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ABSTRACT

This guide is intended to assist industrial arts/technology education teachers in helping students in grades K-12 understand the impact of computers and computer technology in the world. Discussed in the introductory sections are the ways in which computers have changed the face of business, industry, and education and training; the scope and sequence of industrial arts from the elementary through the secondary grades with specific guidelines for each grade level; the goals and provisions of the Education for All Handicapped Children Act; and the purpose and organization of the guide. The second major section consists of computer study and applications units on the following topics: history and development of computers, principles of computer systems, computer-aided design/drafting (CAD), computer graphics, computer-aided manufacturing (CAM) and computer-integrated manufacturing (CIM), microprocessors, robotics, telecommunications, computer-assisted instruction (CAI), data management, and careers. Presented next is an implementation suggestion matrix that proposes a wide variety of ways in which computer use might be integrated into industrial arts programming. Hardware system configurations for a general-use computer station are outlined. Appendixes to the guide include lists of related periodicals, software resources, and software evaluation criteria; a glossary; and a bibliography. (MN)

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CURRICULUM GUIDE
FOR
COMPUTER UTILIZATION
IN
INDUSTRIAL ARTS/TECHNOLOGY EDUCATION

Prepared for

State Department of Education
Division of Vocational, Technical and Adult Education

Prepared by

Connecticut Industrial Arts Association

All opinions expressed reflect the views of the authors and are not necessarily those of the State Department of Education.

June, 1986

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INTRODUCTION

"The greatest impact of computers on education is likely to result, not from the study of computers, but rather from the application of computers in other subjects."[1] It is in the spirit of this statement that this Computer Utilization in Industrial Arts/Technology Education Curriculum Guide has been developed.

Clearly the computer has changed the face of business and industry both large and small. The microcomputer and its related technology have extended this revolution into the home and ultimately this computer revolution has impacted our schools and their programs. School Tech News (April 1986) reports that the student-computer ratio for U.S. K-12 schools has fallen 61% in the last three years to 52 to 1 at the beginning of the 1985-86 school year. One out of every three high schools with computers now has at least one microcomputer for every 29 students. Today's students are children of the computer revolution and the information age it has spawned. They come to us no longer in need of "computer literacy" but rather in search of the next step much as the child who has learned to walk becomes eager to run.

"Industrial Arts (Technology Education) educators who understand the promise of the computer and foresee its inherent problems, can and will play a key role in making their programs an important part of the school's response to this challenging time in our nation."[2] As we begin to effectively deal with this computer revolution as it affects our Industrial Arts/Technology Education program, we need to broaden our focus not only on the computer itself but on the high technology behind and around the computer. As we search for ways of implementing "computers" in our classroom, we must look beyond the deluge of rote drill and practice material to the creative real applications of computers and computer technology. Our areas so naturally lend themselves to the study of CAD, CAM, Robotics, microprocessors, computer graphics and the wealth of other diverse computer applications as well as the study of the underlying microchip technology itself.

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[1] A Guide to Computers in Education, CT State Board of Education, 1985, p. 34.

There are, however, pitfalls we should be alert to. Perhaps the worst of these is the mere placement of a computer in a lab with the expectation that educational miracles will occur. "Simply putting 'new tech' equipment, such as computers and robots, in an 'old tech' shop with an 'old tech' teacher using an 'old tech' curriculum and 'old tech' methods is not a proper response to the computer revolution."[3] The CNC machines and other computers must be showcases not dust collectors. This will only occur if all parties to the education process from the State Department of

[2] School Shop, April 1985, p. 22.

[3] School Shop, April 1985, p. 23.

Education to the local school board to the teacher in the lab recognize the need for curriculum, program, and skills revision and all take responsibility in the pursuit of the needed change. Activities such as this curriculum guide are a step in that direction. It is ultimately up to us, the professionals in this area, to seize this opportunity and make Industrial Arts/ Technology Education the "new basic;" and what better vehicle to complete the Math/Science/Social Studies/Technology connection than the Computer!

INDUSTRIAL ARTS SCOPE AND SEQUENCE

Industrial Arts learning experiences are sequential, beginning in the lowest grades and continuing through adult and higher education. As an integral part of the total educational program, Industrial Arts is designed to meet student's needs as they relate to a modern technological society. Through maniuplative and research experiences, with a variety of tools, machines, processes and products of industry, students develop an awareness of how industry and its many components function.

A comprehensive Industrial Arts program will provide for a sequence of courses in industrial areas. These include, but are not limited to:

Drafting
Electricity/Electronics
General Laboratory
Graphic Arts
Industrial Ceramics
Metal Technology
Plastic Technology
Power Technology
Wood Technology

The objectives of Industrial Arts are:

... To develop an insight and understanding of industry, its place in our society, and the free enterprise system.

... To develop problem solving skills related to the materials, tools, processes and products of industry.

... To provide for a degree of skill development through a series of sequential courses in common industrial areas with vocational emphasis at the advanced levels.

... To develop knowledge of the tools, machines, materials and processes of industry through their practical and safe use.

... To develop an appreciation of good design and craftsmanship.

... To develop an understanding of industrial and technological career opportunities and their requirements.

... To develop those traits which will help students obtain and maintain employment.

... To develop consumerism regarding the goods and services of industry.

... To discover avocational and recreational interest.

... To understand the affects of industry and civilization upon the environment.

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The following sequential phases represent a range of Industrial Arts activities from kindergarten through adulthood. Reference is made to grade level to assist local education agencies (LEA's) in planning. It is understood that a wide vareity of grade organizations are employed based upon local situations.

I. Self-Awareness (grades K-6)

Industrial Arts at this level is designed to familiarize students with the many kinds of work people do and the tools and materials they use. It is at the elementary level that Industrial Arts activities are used to enhance basic skills and understanding in all curricular areas by providing relevant hands-on experiences.

II. Industrial Arts Exploration (grades 7 & 8)

Industrial Arts at the middle school/junior high school level is designed to foster the development of a strong foundation in the concept, skills, knowledge and attitudes regarding not only the technical but also the related and social aspects of general education.

Industrial Arts experiences at this level are exploratory in nature. The program provides students with the opportunity to develop a better understanding of their interests, abilities and aspirations. Consumer knowledge as it relates to industrial products and processes is an inherent part of these activities. A broad exploratory Industrial Arts program at the middle school/ junior high school level allow individual student's interests to become more discernible for concentration at the senior high level.

III. Industrial Arts Occupational Orientation - (grade 9 & 10)

Industrial Arts at this level emphasizes occupational orientation. It is here that the transition from middle school/junior high school exploratory experiences to specialization at the upper levels is made. Students may explore in greater depth a wider variety of areas, evaluate their performance, aptitudes and interests and begin to formulate career plans.

IV. Industrial Arts Specialization (grades 11 & 12)

At this level students are provided the opportunity to specialize in one or more occupational areas and to develop pre-vocational skills. Training at this level should prepare students to maximize their career options after high school.

This level should also assist individuals in making informed and meaningful occupational choices and/or prepare them for entry into advanced trade and industrial or technical education programs.

V. Adult, continuing and higher education Industrial Arts programs are designed for adults and out of school youth. These programs are avocational, pre-vocational or vocational in nature depending upon the needs of the individual and the demands of society.

Specific Guidelines for Industrial Arts

Grade Level

7 - 12 and Adult

Selection of Students

Open to all students who can profit from instruction, and work safely in a Lab/Shop situation.

Length of Program

Level One (Exploratory) grades seven (7) and eight (8) - Lab/Shop classes meet a minimum of 60 hours per year. Lab/Shop periods must be of at least 40 continuous minutes and should ot exceed 60 minutes.

Level Two (Occupational Orientation) grades nine (9) through twelve (12), or grades ten (10) through twelve (12) - students electing Level Two Industrial Arts courses must have the opportunity to participate in a minimum of 225 minutes of Lab/Shop activities per week, per semester. Daily Lab/Shop periods must be of at least 45 continuous minutes and should not exceed 60 minutes.

Level Three and Four (Specialization and Pre-Vocational) grades eleven (11) and twelve (12). Students that elect Level III & IV Industrial Arts courses must have a minimum of 450 minutes per week, per year of Lab/Shop activities. Daily

Lab/Shop periods must be of at least 90 continuous minutes.

The definition of a year is a minimum of 180-day school days. A semester is 90 continuous school days.

Pre-Requisites

Successful completion of Level Two course prior to participating in Level Three. Successful completion of Level Three course prior to Level Four.

Enrollments

Based on Lab/Shop size and facilities, 16 students per class maximum in Lab/Shop areas and 20 students per class in drafting. The recommended and minimum square footage are as follows:

Shop/Lab

	Recommended		Minimum	
Jr. & Sr. High Sch.	s.f./pupil station	Net total s.f. area	s.f./pupil station	Net total s.f. area
Drafting (including storage)	48 s.f.	1000 s.f.	40 s.f.	1000 s.f.
I.A. Jr. H.S. Level One (including storage)	100 s.f.	2500 s.f.	82 s.f.	2050 s.f.
I.A. Sr. H.S. Levels Two, Three, & Four (including storage)	144 s.f.	3600 s.f.	120 s.f.	3000 s.f.

A classroom should be made available for related study, adjacent to the Shop/Lab areas. All facilities must comply with OSHA regulations.

Teachers Schedule

Industrial Arts contact hours for a full-time instructor should comprise 70% to 80% of their school week, and 20% to 30% of their time in industrial arts related non-teaching duties, such as maintenance and preparation of I.A. materials.

Equipment

All equipment must be in safe operating condition and conform to all federal, state, and local standards. Equipment must be:

A. Applicable to the level being taught, i.e., size, capacity, quantity, and necessity.

B. Enhance the program level and be similar to that found in industry.

C. Take into consideration: Occupational education, consumer competency, leisure time activity, and environmental awareness.

Evaluation

Continuous evaluation by students, teachers, school, vocational, advisory committee, and state. Evaluation results must become an integral part of program development and improvement.

School Credit

Equal to other academic credit granted for similar periods of time and activities.

Youth Organizations

It is recommended that the American Industrial Arts Student Association (AIASA) be an integral part of the curriculum.

Teacher Certification

Instructors shall meet the minimum standards for Industrial Arts teachers provisional certification as outlined in the "Rules and Regulations Concerning State Teacher Certification" Section 10-146-21 and Section 10-146-22.

Standard certification requires three (3) years of teaching under a provisional certificate, the last two (2) years consecutive and a master's degree or thirty (30) semester hours, consisting of a planned program at an approved institution of higher learning and an individual program, mutually determined and approved by teacher and supervising agent.

Teachers of Industrial Arts to be funded through the Vocational Education Acts must comply with Section 10-146-22 above, have one (1) year of appropriate occupational experience and complete Principles of Vocational Education, a three (3) semester hour Vocational-Technical Education course.

Sex Stereotyping

Existing activities and future plans must show evidence of actions directed toward the elimination of sex stereotyping, including continual effort to attract females to elective industrial arts courses traditionally chosen by males. Industrial arts courses which are required for any students at a particular level must be required of all students, male and female.

PUBLIC LAW 94-142

"THE EDUCATION FOR ALL HANDICAPPED CHILDREN ACT"

This law requires that all handicapped children requiring special education have available a free and appropriate public education in the least restrictive environment. The law establishes guidelines for meeting this goal. Following is some terminology the instructor should be familiar with.

Special Education is specially designed instruction at no cost to parents. It must meet unique needs of handicapped children and be provided with a written individualized education program (IEP).

An Individualized Education Program is a written document by parents and teachers for a handicapped child before he receives special education. The IEP is produced by a planning and placement team (PPT) meeting. The IEP reviews the present educational performance of the child, goals and objectives for the child, and specific services to be provided by the school.

A Planning and Placement Team is a legally established group developing or reviewing the IEP for a handicapped child. It is composed of teachers and the child's parent(s) to review information regarding the student in response to a referral for special education evaluation or to conduct an annual review.

Handicapped means:

(a) A person who is;

1. Mentally retarded
2. Hard of hearing
3. Deaf
4. Speech impaired
5. Visually handicapped
6. Seriously emotionally disturbed
7. Orthopedically impaired
8. Other health impaired person, or persons with specific learning disabilities.

(b) Who, by reason of the above;

1. Requires special education and related services
2. Cannot succeed in the regular vocational education program without special educational assistance
3. Requires a modified vocational education program (Federal Register, Vol. 42, No. 191, Oct. 3, 1977, p. 53864)

Disadvantaged means:

(a) Persons (other than handicapped persons) who;

1. Have academic or economic disadvantages
2. Require special services, assistance, or programs in order to enable them to succeed in vocational education programs.

(b) Academic Disadvantage: For the purposes of this definition of disadvantaged, means that a person;

1. Lacks reading and writing skills
2. Lacks mathematical skills
3. Performs below grade level

(c) Economic Disadvantage: For the purposes of this definition of disadvantaged, means;

1. Family income is at or below national proverty level
2. Participant or parent(s) of participant is recipient of public assistance
3. Participant or parent(s) or guardian of the participant is unemployed
4. Participant is institutionalized or under State guardianship (Federal Register. Vol. 42, No. 191, Oct. 3, 1977, p. 52864)

Mainstreaming: Though this term does not occur in P.L. 94-142, it is a coined term thought to mean placing all handicapped learners into regular classrooms. This is not the intent of the law. Rather, handicapped learners should be placed in the least restrictive environment.

Least Restrictive Environment: Public schools must assure that, to the maximum extent appropriate, handicapped students are to be educated with non-handicapped students. Separate classes should occur only when the severity of the handicap is such that education in the regular classroom with supplementary aids cannot be accomplished adequately. If a handicapped student is disruptive to the extent of interfering with the learning of other students in a classroom, this placement would be considered inappropriate. Thus a shop, home economics class, business class, may be inappropriate for some handicapped learners.

Role of the Special Needs Teacher: The special needs teacher should be supportive to the extent of helping the regular teacher identify specific characteristics and needs of every special needs student. He should help, when needed, in teaching special needs students in the classroom. Needs and placement should be jointly determined by the regular and special needs teacher.

HOW TO USE THIS GUIDE

This guide was developed to help the Industrial Arts/Technology Education teacher help students to understand the impact of computers and computer technology on the world in which we live. It is designed to be a central information source for the teacher to use as a reference in reseaching and preparing to use computers in the Industrial Arts/Technology Education lab. Background and technical information is presented for the study "of and about" computers themselves. The computer as a utility or tool is the focus of most of this guide. This is reflective of the current state of computers in business and industry. Most people in the workplace are involved with computers in an application format, that is, using the computer to do a job: faster, more accurately, and with greater flexibility and power than ever before possible.

Because this guide is to be a resource for teachers in all areas of Industrial Arts/Technology Education and not a daily prescription for any single course or group of courses, the guide is not written in the behavioral objective format. Rather, it is written so that any teacher could find the guide useful in: utilizing computers in a course presently taught, planning a new course, modifying or adapting courses etc.

It is anticipated that this guide will actually spawn a series of new guides which would be aimed at students in specific courses. Areas that could be expanded into curriculum guides of their own include but are not limited to: CAD, Robotics, or Microprocessors.

The committee approached the writing of this guide from the perspective of the teacher who wanted to know more about computers so that he or she might become infected with the enthusiasm a young child has for a new video game, and so, infect the students with the same enthusiastic pursuit of computer skill and utility yet unimagined. Toward that goal the committee wishes you well and hopes that it has been of some small help.

It should be noted that mention of specific brands of hardware or software as well as prices has been intentionally avoided for a number of reasons, not the least of which is the rapidly changing market place of both companies and models.

COMPUTER STUDY AND APPLICATION UNITS

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Unit 1 - History and Development of Computers

A. History

Computers that enable people to rapidly perform computations are by no means a new concept. At some point in antiquity, one of our sophisticated ancestors realized that by using some object to represent digits, it might be possible to perform computations beyond the limited scope of one's ten fingers and ten toes. Shells, chicken bones, and peach pits have been used, but the fact that the word "calculator" is derived from calculus, the Latin word for small stone, suggests that pebbles were in great demand. Ultimately, such pebbles or beads were arranged to form the familiar abacus, the first man-made computing device.

In 1642, a French mathematician named Blaise Pascal invented an adding machine based on the principle of the abacus. Thirty-two years later, Gottfried Wilhelm von Leibniz made several improvements on Pascal's machine. The device could now multiply and divide as easily as it could add and subtract. In 1850, D. D. Parmalee, an American inventor, devised a system by which properly marked keys turned wheels, eliminating the need to do so by hand.

In the late 18th century, Joseph Marie Jacquard, a Frenchman, invented a mechanical loom, which wove fabric in a variety of patterns based on instructions entered on a series of punched cards.

In 1833, Charles Babbage, English mathematician, applied the punched card concept to a machine called an "analytical engine." In 1980, Herman Hallerith, working for the U.S. Census Bureau, devised a series of holes punched into cards. In 1911, the IBM company came into existence.

The Burrough adding machine made its first appearance in 1885, and in 1917, just in time for WW I, a calculator that could add, subtract, multiply, and divide came on the scene. In 1925, Vannevar Bush, an American electrical engineer, built a machine that could solve different equations.

In 1937, Howard Aiken, of Harvard University, envisioned a completely automatic electromechanical computer. In 1944, the automatic Sequence Controlled Calculator was invented (MARK I). When computers were first invented during WW II, they were immediately put to use computing artillery firing angles.

In the 1940's, the transistor arrived on the scene; and in the late 1950's and early 60's, the integrated circuit or I.C. was developed. In 1970, the first microprocessor chip was produced. An honest to goodness computer revolution occured in 1971 when Intel Corp. produced the first microprocessor or "computer on a chip."

In 1973, computer software was developed by John Keweny and Thomas Kurtz at Dartmouth College. The Altair was the first commercially successful microcomputer, in 1975.

From 1975 to the present, large companies have been offering microcomputers and accessories to a fast growing market which grew to include people from nearly all walks of life.

B. Time Line

500 B.C.	ABACUS
1642	BLAISE PASCAL'S - ADDING MACHINE
1820	THOMAS DE COLMAN - ARITHMOMETER
1890	HOLLERITH - U.S. CENSUS MACHINE
1937	MARK I - HARVARD UNIVERSITY
1938	ATANASOFF & BERRY - ELECTRONIC CALCULATOR
1942	IBM - FIRST CARD PROGRAM CALCULATOR
1943	COLOSSUS - USED TO BREAK GERMAN SECRET CODES
1946	ENIAC - UNIVERSITY OF PENNSYLVANIA
1952	UNIVAC - ECKERT & MAUCHLY
1960	INTEGRATED CIRCUIT
1970	FIRST MICROPROCESSOR CHIP
1971	FIRST COMPUTER ON A CHIP
1973 TO PRESENT	COMPUTER SOFTWARE - DIVERSE & WIDE-SPREAD COMPUTER HARDWARE - SMALLER, FASTER, MORE POWERFUL

C. Power, Memory Size, Speed

For centuries, man's ability to probe the mysteries of the physical universe was limited by the lack of appropriate tools. Pascal's Arithmetic Machine and Leibuiz's calculator performed four operations of arithmetic.

Calculations and paperwork mushroomed in business and government throughout the 19th century. Clerks by the thousands working night and day, barely kept up with the growing volume. The situation steadily worsened at the U.S. Bureau of the Census. It took nearly seven years to compile the data gathered in the census of 1880, and when finally published, the information was obsolete and practically useless.

By 1940, the punch card data processing was firmly entrenched in business and government. Every day tens of thousands of mechanical sorters, collators, and tabulators whirred and chewed their way through the steady rising torrent of paperwork.

For the business community, the ceiling on processing speed was a bother and an expense. In 1943, an electronic calculator known as ENIAC performed as many as 5,000 additions in one second.

In 1937, George Stibitz built his legendary "kitchen table computer" in one weekend, by adding in binary with the aid of a simple logic circuit.

In 1940, Williams and Stibitz completed their Complex Calculator. The average operating speed of the relays was around 10 milliseconds. This meant that 40 numbers could be added in about half a second. This venture into automatic computing cost the telephone company $20,000 - an astronomical sum in those days.

Shortly, an electronic computer was made having over 17,000 vacuum tubes of 16 different types, operating at a fundamental clock rate of 100,000 pulses per second. The machine was a synchrouous one, receiving its beat from a clock which issued a signal every 10 microseconds. In a single second there were 1.7 billion chances of a failure occuring.

In the late 1940's, BINAC produced a memory capacity of 4,500 decimal digits; UNIVAC produced 600,000 decimal digits per minute, and 30,000 multiplications of two numbers, each up to 10 decimal digits.

Computer speed is what accounts for the dramatic problem-solving efficiency we hear so much about. And miniaturization makes this awesome power and speed possible at almost inconceivably small sizes. In 1960, the typical processor had 100 active components (electrical parts) per cubic centimeter (CCM). Today the figure is 10 million components/CCM, and by 1990 the prediction is another 1,000 times that!

Let's look at this from another angle. One dollar could buy the execution (processing) of 100,000 single operations (like adding or subtracting) in the late 1950's. In the 1960's the figure was 1 million operations per dollar, and by 1970, more than 100 times greater than that! Computer capacity that cost $30,000 in 1970 cost just $4,000 in 1977, and could cost less than $100 within two to three years from now!

D. Future

Experts argue about whether or not computers will ever become true "artificial intelligence," themselves capable of autonomous, humanlike thought. The connection between AI and the "metaphysical computer" is apparent. As soon as you take seriously the idea of creating an AI, you face questions such as whether we have any more than sentimental reasons to believe that there is something about people that makes it impossible to capture our intelligence in machines. Can an intelligence without a living body, ever really understand human beings? AI researchers study minds in order to build programs, and they use programs to think about the mind. Some questions that need to be answered are: "Are computers alive?" "What is life?" "What makes us special?"

In the 1950's, there was a growing belief among a group of mathematicians of diverse interests that a "general-purpose" intelligence or mind could be programmed in a computer. Study was done at Dartmouth that would take the first practical step towards translating these ideas into vigorous attacks on the problem of AI. A specialized AI lab was set up at Carnegie Mellon.

Some AI researchers go so far as to say that the industrialist of the future might itself be a computer, or as one scientist puts it, "AI is the next step in evolution." For the moment, people's deepest concerns are not on the practical but the philosophical. Whether or not AI can make robots with superhuman powers has material consequences of the first magnitude. It is not too far away. What is here and now is the challenge of a new philosophy.

Unit 2 - Principles of Computer Systems

It has been said that a computer is a "fast idiot." It will not do anything unless you tell it to do so. It is very obedient; it will only do as you command, nothing else. Let's see why this is so.

A computer is defined as a general purpose programmable machine which will follow sequential instructions. The computer system is composed of two major components, the hardware and the software. One is dependent on the other. You can think of the hardware/software analogy in relation to a phonograph. The hardware is the turntable, the software is the record which would be played. Again, they are mutually dependent.

This unit will describe types of hardware and software currently available, and will also describe some of the languages available with which a computer may be programmed.

A. Hardware

   1. Input Devices

      a. Keyboard

         1. Used for entering textual, graphic, and control sequences into computer

      b. Card Readers

         1. Uses the 80 Column Hollerith cards
         2. Holes punched in card represent information
         3. Cards often are useful for recording

separate order transactions, though with more efficient methods of data recording, use of Card Readers will soon end.

c. Magnetic Character Recognition

d. Optical Character Recognition

    1. The high-speed process of converting machine or hand printed numerals, letters, and symbols into computer-processable information by an optical scanning system.
    2. 'c' and 'd' are similar, though magnetic character recognition is the older of the two processes
    3. Due to advanced technology, Optical and Magnetic Character Recognition will fall into disuse.

e. Light Pen

    1. Used for pointing on a screen, or for drawing

f. Joystick

    1. Device which tracks cursor to screen on x - y axis

g. Digitizer

    1. Converts analog signal into digital signal
    2. Useful for Computer Aided Design programs

h. Trackball

    1. Similar in function to joystick and light pen
    2. Cursor control more precise

i. Voice Recognition
  1. Words programmed to represent keystrokes
  2. Can only be used by a few people
  3. Limited vocabulary (at time of writing)

j. Mouse
  1. Upside down trackball
  2. Becoming very popular

k. Page Scanner
  1. Scans whole page of text so text does not have to be typed in
  2. Page must be typed of typeset quality
  3. Not enough sophistication to read handwriting

l. Input devices for the handicapped
  1. Large keypads
  2. Voice input devices
  3. Pointers for motor impaired

2. Processing Devices
  a. Central Processing Unit
    1. Arithmetic-Logic Unit
      a. Operates on a pair of numbers and carries out on them the processes of addition, subtraction, multiplication, and division
      b. Compares numbers and determines whether one is greater than, less than, or equal to the other

2. Control Unit
   - a. Supervises the functioning of the machine as a whole, calling into operation the various units as required by the program.
   - b. The control unit receives the program instructions one by one in sequence, interprets them, and sends appropriate control signals to the various units

3. Memory
   - a. Used by arithmetic/logic and control units
   - b. Memory on Microcomputer measured in Kilobytes (units of 1000 characters) - actually 1024 bytes
   - c. Earlier microcomputers (1980) had about 16 Kilobytes; 1986 micros have between 128-512 Kilobytes of main memory
   - d. It is possible to add a few Megabytes of memory onto main board (depending on how much memory the microprocessor can directly address)

b. Auxilliary Boards

1. Memory
   - a. Added boards slips into an empty slot in computer. Computer uses "bank switching" to read data in memory. Bank switching

is similar to searching for data on separate pages. First one page is searched, then another

2. Co-Processors
    a. An additional microprocessor which takes over math intensive calculations, thereby speeding up the overall operation of the computer
3. Modems
    a. Permits communication between computers via the phone lines. (See Chapter on Telecommunications)
    b. Converts computer's digital signal to analog signal for use on phone lines
4. Parallel and Serial Interfaces
    a. Hardware which permits communication between computer and other peripheral
        1. Parallel Interface
            a. Signal is sent at a faster rate than through serial interface
            b. Can not operate over distances greater than 6 to 8 feet
        2. Serial Interface
            a. Signal is sent at a slower rate than through parallel interface
            b. Distance sent is length of wire/cable

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3. Output Devices
  a. Printers
    1. Dot Matrix
      a. Uses matrix of pins to strike ribbon, imparting image on paper
      b. Three basic print modes
        1. Draft
          a. Can see individual dots of letter
          b. Can be hard on eyes
        2. Emphasized
          a. Heavier print
          b. Easier to read
          c. Takes longer to print
        3. Near-letter-quality
          a. Approaches quality of print from a typewriter
          b. Can sometimes be used for business correspondence
          c. Can be used for graphics
          d. Most versatile of printers
          e. Can change font style under software control
    2. Ink Jet
      a. Matrix of electrically charged drops of ink
      b. Good for graphics and color printing
      c. Jets must be cleaned (depending on

manufacturer)

3. Thermal transfer
    a. Matrix of pins
    b. Pins heated, comes in contact with polymer ribbon, transfers image on paper
    c. High print quality
    d. Ribbon can be used only once
4. Daisy Wheel
    a. Uses wheel with individual petals resembling a daisy flower
    b. Hammer strikes petal to ribbon to paper
    c. Sharpest image quality
    d. Ribbon can be used only once
    e. Can only change font if the daisy wheel is changed
    f. Not good for graphics
5. Laser Printing
    a. Uses laser to charge drum to transfer image to paper
    b. Excellent choice for graphics and typesetting
    c. Significantly more expensive than other types of printers
6. Plotter
    a. Uses pens to draw image
    b. Sizes of bed (to handle paper)
        1. A = 8-1/2" x 11"

2. B = 11" x 17"
3. C = 17" x 22"
4. D = 22" x 34"

c. Two types of plotters

1. Flatbed

a. Paper is held to bed, pen or pens move on x - y axis

2. Drum

a. Paper moves on y or x axis and pen moves on y or x axis depending on how paper is inserted

d. Typical use: CAD output

b. Screens

1. Television Screens

a. Uses Radio Frequency Modulator to convert signal from computer

b. Cannot clearly display more than 40 character across screen, so it is not recommended for word processing or for high resolution graphics

2. Computer Monitors

a. Monochrome Monitors

1. Display Monitor

a. More scan lines on screen

b. More dots to compose text on screen

c. As a result, has higher resolution than a composite monitor

d. Must be used with IBM/compatible equipment

2. Composite Monitor

a. 80 readable characters across screen

b. Color Monitors

1. Composite

a. Combination of brightness, synchronization, and color information

b. Similar to color TV, but without its tuner

c. Cannot produce 80 columns of sharp clear text

2. RGB Monitors

a. Stands for Red, Green, Blue - colors which when combined constitute any color the eye can perceive

b. Uses broader bandwidth

c. Much sharper and more vivid color display

d. More expensive than composite monitor

3. Switchable 80 column monochrome/ composite color

3. LCD Screens (Liquid Crystal Display)

a. Often used on portable computers, they take up significantly less space than a standard monitor

        - b. Less power consumption, though the LCD screens may be difficult to read under less than ideal lighting conditions
    - 4. Gas Plasma Displays
        - a. Visible under any light conditions
        - b. Display is sharp and crisp
        - c. High energy consumption

4. Storage Media
    - a. Magnetic Tape
        - 1. Essentially obsolete for microcomputers
        - 2. Very slow loading and save time for programs and data
        - 3. Provides only for sequential access to data
    - b. Diskette
        - 1. Significantly faster and more reliable than tape storage
        - 2. Provides for random access to data
        - 3. Disks must be "formatted" for each brand of computer. Formats are incompatible from one brand to another. Care must be taken in the storage, use and handling of disks.
        - 4. Relatively limited storage of data and programs
        - 5. Three common sizes
            - a. 3-1/2" mini disk
                - 1. Hard cover protects magnetic surface

    2. Storage 800 kilobytes to 1.6 Megabytes
    3. Popular for portable computers (Laptops)
  b. 5-1/4" Floppy Disk (Flexible)
    1. Most popular format
    2. Bendable - can be damaged
    3. Storage 124 Kbytes to 720 Kbytes
    4. Magnetic surface exposed to dust, dirt, spills, etc.
  c. 8" disk
    1. Usually used on larger micro to mini computer systems
    2. Storage 1-2 Megabytes

c. Hard Disk
  1. Data Read/Write significantly faster than floppy disk
  2. Disk in enclosed so can not be damaged by dust
  3. Available in removable cartridges
  4. Storage capacity 5-20 Megabytes
  5. Takes the place of 50 to 200 Floppies

d. Bubble Memory
  1. Uses semiconductor technology to store data
  2. Non-volatile: shut computer, memory remains
  3. Relatively expensive compared to magnetic disk media storage, but with mass production

and greater demand, prices should come down

4. Good for small, portable computers

e. Optical Storage (Compact Disk)

   1. Called "CD ROM" (Compact Disk Read Only Memory)

      a. Storage capacity of 500-600 Megabytes

   2. Uses similar technology as laser disk or Compact Digital Audio Disk

   3. Disk can be read from, and written to only once as, when written to, laser burns small pit in disk to represent value of "on."

B. Software

1. Definition

The term "software" is used to describe the non-hardware components of the computer, in particular the programs that are needed to make the computer perform its intended task(s).

2. Operating System Software

A collection of programs designed to permit a computer system to manage itself and to avoid idle CPU time while increasing utilization of computer facilities.

a. Examples of Current Operating Systems

   1. Apple DOS (Disk Operating System)
   2. MS-DOS (Micro Soft, Inc.)
   3. PC-DOS (IBM Corp. Operating System)

3. Software/System Life Cycle
    a. How Software is Developed
        1. Define problem
        2. Draw up alternative solutions
        3. Determine best solution
        4. Flowchart or write in Pseudocode
        5. Code the program
        6. Test the program
        7. Implement the program
        8. Document the system (done throughout the life cycle)
4. Self-written Software
    a. Requires much time to write effective programs
    b. Advantage is that program could be written for exactly what user/programmer wants/needs
    c. Cost of programmer's time should be weighed against the cost of purchasing commercial packages
5. Commercial Software Packages
    a. Could be expensive, depending on sophistication of program
    b. Very often copy-protected-difficult to make back-up copies of purchased software
    c. May be less expensive to purchase rather than program in-house
    d. Commercial software may not do exactly what the user wants

6. Care and Handling of Software
   - a. If commercially bought, register with manufacturer to receive updates
   - b. Physical handling of software
     1. Avoid letting dust, dirt, smoke, coffee come into contact with magnetic media
     2. Don't bend disks
     3. Don't freeze or heat disk
     4. Don't allow magnetic material (magnet, paperclip) to come into contact with disk
     5. don't expose to magnetic theft sensing devices or other devices with strong magnetic fields i.e. T.V.'s, digitizer tablets, speakers, etc.

7. Copyright Laws

The educator should observe the provisions of the copyright laws which typically read as follows:

> YOU ARE LICENSED TO USE THE PROGRAM ON A SINGLE MACHINE ONLY. YOU MAY NOT USE, COPY, MODIFY, OR TRANSFER THE PROGRAM, OR ANY COPY, MODIFICATION OR MERGED PORTION IN WHOLE OR IN PART, EXCEPT AS EXPRESSLY PROVIDED FOR IN THIS LICENSE. IF YOU DO SO, YOU TERMINATE YOUR LICENSE.

Since educators often purchase software for use on more than one computer, it would be advisable to consider buying a site license when available which would permit multiple copies to be made.

C. Languages

1. Interpreted Languages

   Being that a program is composed of a number of lines of code, it is necessary for the computer, when running the program, to look at each line, and translate it into its own machine language which it would understand. This process would take place over and over until the program run has ended. This process tends to be rather slow compared to languages which are compiled (see below).

2. Compiled Languages

   Compilers are languages which have the task of translating the source code into machine code which the computer understands. The resulting code is called "object code." The process takes place once, and the resulting code runs significantly faster than interpreted code (see above).

3. Flow Charts

   Flow charts are a collection of symbols used to represent the logic flow in a computer program. Each symbol represents a different process. Any process can be represented by one or a combination of: Sequence, Iteration, or Selection.

4. Names, Characteristics, and Applications

   a. Machine

      1. Language computer can directly understand
      2. Written in binary, octal, or hexadecimal

3. Very tedious to program and debug
4. Very fast program operation
5. Machine dependent
6. Example: Add two numbers

```
3A 60 00 47 3A
61 00 80 32 62
00
```

b. Assembly

1. Uses menmonics instead of binary coding
2. Often used to program operating systems
3. Machine dependent
4. Example

```
READRT  GET INCARD,INWORK, READ INTO INWORK
        MVC LIMOUT,LIM SET UP PRINTLINE
        PACK LIMP (3), LIM PACK LIMIT
        LOOP AP ANSP, CTR ADD CTR TO ANSP
```

c. BASIC

1. Stands for Beginner All purpose Symbolic Instruction Code
2. Easy to learn
3. Does not foster structured programming techniques
4. Example

```
10 FOR I = 1 to 10
20 INPUT "TEST SCORE": T
30 SCORE = SCORE + T
40 NEXT I
```

```
50 PRINT "AVERAGE = ": SCORE/I
60 END
```

d. COBOL

1. Stands for COmmon Business Oriented Language
2. Machine independent
3. Very lengthy and wordy
4. Language is standardized
5. Self Documenting
6. Strong file handling capabilities
7. Example

```
PROCEDURE DIVISION
   DISPLAY EMPLOYEE NAME, NET PAY
   OPEN INPUT CARD-FILE OUTPUT FILE
   READ CARD-FILE AT END GO TO FINISH
   MULTIPLY WAGE-PER-HOUR BY 40 GIVING
      REGULAR PAY
   MOVE EMPLOYEE-NAME REGULAR PAY TO
      PRINT LINE
   PERFORM WRITE-PRINT-LINE
```

e. FORTRAN

1. Stands for FORmula TRANslator
2. Was first high level language - 1957
3. Is very efficient as a mathematical language
4. Does not handle files well
5. Example

```
WRITE (6,1)
1 FORMAT ( 1 , EMPLOYEE NAME , SX, NET PAY)
```

```
2 READ (5,3) NA, NB, NC, ND, NHOURS, WAGE, IEND
IF (IEND, EQ, 99) STOP
IF (NHOURS .GT. 40) TO 10
10 REG = 40. * WAGE
END
```

f. LOGO

1. Is a procedural, interactive language
2. Makes use of "Turtle Graphics"
3. Example

```
TO NEWLOOP : SIZE
IF : SIZE  20 STOP
NEWTRIANGLE : SIZE
CREEP : SIZE/2
RIGHT 60
NEWLOOP : SIZE - 5
END
```

g. PASCAL

1. Good educational language for teaching structured programming
2. Permits complex data structures
3. Example

```
Program SumTwoNumbers;
  Var
    Num1, Num2, Total : Integer;
Procedure GetNumbers;
    Begin
    Writeln (Enter two numbers);
```

```
        Readln (Num1, Num2);
        End;
    Procedure GetTotal;
        Begin
          Total: = Num1 + Num2;
          Write (Total = , Total);
          End;
        Begin (main program)
          GetNumbers;
          GetTotal;
        End.
```

D. Control Systems

Computers lend themselves very readily to real time applications, meaning the efficient analysis and control of the performance of complex devices and processes.

A simple example is the control of a hot water heater. The stimulus is the cycling on and off of the heat sensor, sending an electrical signal to the computer, which reads the signal, determining if it is above, at, or below a programmed value (processing). Appropriate action (Response) is then taken by the lowering or raising of the flame under the boiler.

1. Control Cycle
    a. Elements of the control loop
        1. Comparator

      2. Control Algorithm
      3. Manipulated Variable
      4. Sensors
      5. Feedback Variable

2. Hardware Components
   a. Sensory Inputs
   b. Processor
   c. Control Outputs
   d. Communication Hardware
   e. Real-time clock
3. Applications
   a. Industry
      1. Numerical Control
      2. Robots
   b. Business
      1. Security
      2. Environmental Systems
   c. Home
      1. Security
      2. Environmental Systems
   d. Transportation
      1. Traffic Control
      2. Defense
      3. Navigation Systems

Unit 3 - CAD: Computer Aided Design/Drafting

A. Concepts

1. CAD is the organized use of a computer, monitor, input device and CAD software to perform drafting and design tasks. These tasks can range from the simple and repetitive to the complex. Since all drafting skills can be reduced to the use of lines, arcs, points, symbols and text, most CAD systems deal with these primatives and the many ways of grouping, reusing and manipulating these items. The primatives are used to create more complex drawings through the use of any number of input devices to form the drawing on the screen. Through the use of the software the drawing can be modified, stored or dumped to a plotter to produce a hard copy. PC Magazine of July 1984 stated that "CAD programs are to images what word processors are to words: You use them to create, edit, and make hard copy, but the medium is pictures. CAD can be thought of as image processing."

2. Computer Use in Design and Drafting
   a. Developing simple drawings through the use of primatives
   b. Using groups and symbols to create drawings
   c. Creating your own symbols - any commonly used drawing or part of a drawing can be

grouped and reused in other parts of a drawing or other drawings to simplify repetitive tasks.

   d. Modeling and testing in 3-D systems
   e. Increased accuracy and repeatability of any task

3. Direction of the Industry
   a. More systems hitting the market every day
   b. Steady increase in use by industry as systems become more versatile and less costly
4. Advantages to Industry
   a. More productivity in the long run
   b. Ease of editing existing drawings
   c. Reduced space for drawing storage
   d. Uniform drawing quality
   e. Increased quality of reproductions
   f. Reduced set-up time on new drawings
   g. Increased ability to retrieve and use data from drawings for testing and design
5. The role of the school system in implementation
   a. Student exposure on actual micro-based systems
   b. Familiarity with terms
   c. Familiarity with new technology
   d. Increased student awareness of the job opportunities available in the field of Drafting, Design and CAD

B. Goals
   1. Familiarity with concepts
   2. Develop new approach to design as well as drafting - CAD systems are not just "electronic pencils"
   3. Develop familiarity with hardware and software
      a. Develop computer awareness
         1. Keyboard skills
         2. Familiarity with different input devices
         3. Computer storage methods
      b. Creating and editing capabilities of CAD
      c. Drawing and image storage capabilities
      d. Hard copy production
   4. Understand connections with other areas
      a. Testing and research
      b. CAM/CIM

C. Applications
   1. Drafting
      a. View development
      b. Pictorials
      c. Mechanical
      d. Architectural
   2. Design
      a. Definition; From Webster's: "to conceive or plan out in the mind, to conceive or draw the plans for, a sketch or plan showing the main features of something to be executed."

b. 2-D

c. 2 1/2-D; "3-D" representation on a 2-D screen

d. 3-D; rotatable and modeled images on the screen having true three dimensional characteristics, length, height, and width

e. Symbol libraries - a resource of commonly used drawing parts which may be used to create new drawings or edit existing drawings

3. Relation to manufacturing and other areas

   a. Drawing reproduction, revision, and storage. Drawings may be reproduced or revised from memory at any time. It is possible to recall a drawing, revise some portion of the work, and if the revisions prove to be unsatisfactory, to restore the drawing to its original state with very little effort

   b. The CAM connection - There are systems presently being developed that will make the CAM connection, the direct link between design and manufacturing. Whether these systems will prove functional in the industrial setting is still to be proven

   c. Electronic schematic and printed circuit design

   d. Testing

      1. Materials testing

      2. Load and engineering testing

        3. Product evaluation testing
    4. Databases
        a. Bill of materials
        b. Pattern, shape, symbol files (libraries)
        c. IGES (Initial Graphics Exchange Standard) - a step toward standardization among CAD turnkey systems

D. Hardware
    1. Micro to mainframe
        a. Turnkey systems - PC based CAD systems
        b. Networked systems - Multi station units which are interconnected and use the same source of memory
            1. Advantages - Single storage and library facility for the shared use of data, smaller work stations per operator
            2. Disadvantages - More chance of system down time, slower access time for data, most often costly than PC based CAD
    2. Micro based system details/CAD station
        a. Base computer with storage medium (media)
        b. Input devices
            1. Keyboard - typing keystroke input of information
            2. Digitizer - (2-D, 3-D) many different sizes to fit the application, allow for the direct transfer of points from existing

drawings to CAD medium

  3. Mouse - light sensitive, roller ball
  4. Light pen-direct screen touching to pick points and commands
  5. Joy stick
  6. Thumb and finger wheel - one wheel for horizontal (x-axis) and one for verticle (y-axis)
  7. Optical scan video camera - direct input of existing drawing and other graphic matter through a video camera and scanning unit

c. Output devices
  1. Plotter
  2. Graphics printer - dot matrix or laser
  3. Photographic reproduction - presentation slides directly from screen image

E. Software
  1. Generic vs. Application specific
    a. Multi-purpose software capable of functioning in any drafting and design situation, usually general drafting/design work
    b. Application specific
      1. Mechanical
      2. Architectual
      3. Printed circuit and electronic schematic

4. Other applications - Most systems will function and perform most drafting tasks but some of the software packages have advantages that make them more suitable for specific areas

2. Capabilities

The following is a list of capabilities which a basic CAD system should possess:

I. Configuration

To be able to set the area represented on the video monitor to any appropriate size for the task at hand. These sizes should be easily scalable to the available plot size to be used.

II. Generate a Grid

Grids are used to aid the layout of a drawing and should be able to be altered to any desired size at any time during the drawing process. The grid dots should appear on the screen but not effect the final plot. Grids should also be able to be turned off and on as desired.

III. Use of Snap

Snap is the ability to regulate the movement of the cursor on the screen in increments which may be set by the user. These increments may be the same as the grid spacing or may be set smaller. The user may desire one inch grid spacing with .25 snap spacing to work with four increments or stops between each dot on the grid.

IV. Draw Using Primitives

Drawings should be able to be generated by the use of lines, arcs, and circles. All drawings can be boiled down to these primitives or entities. There may be other modifications of these three types of entities, such as wide lines called traces or different line styles needed to complete most drafting tasks, but these still reflect back to the three original primitives.

V. Three Methods of Input

Absolute - This method uses the keyboard to type in the actual x and y coordinates desired usually separated by a comma. For example: "3.5,15" specifies a point with an x coordinate of 3.5 and a y coordinate of 15 units.

Relative - This method also uses the keyboard to type in a distance and direction from a previously picked point. The method of keystroking these facts in may vary from software to software but will accomplish the same thing. For example: When using AutoCAD typing "@2.5 45" will cause the cursor to move 2.5 units at 45 degrees.

Pointing Devices - Each system uses a different kind of pointing device but it must be understood that they all do the same thing. They are used to move the cursor on the screen and pick points which are used in the generation of any drawing. This method is by far the fastest but the other methods may be used when accuracy is more critical.

VI. Generation of Text

Text should be able to be generated in a least four methods and at any desired size. The four methods most commonly used are left justified, right justified, centered and aligned. Left justified is the method used to pick a starting point for a text entry and have the entry extend to the right. The right justify method will allow the operator to pick an end point for the desired text and the text will be filled in to the right of this point. The centered method will allow the operator to pick the desired point where the center of the text entry will be placed and the line of text will extend in both directions. The previous three methods require the operator to select the desired height of the text entries. The fourth method, the aligned method, does not require this input. The operator simply selects the starting point and the end point for the text entry and types in the desired text. The system will then compute the length of the line of text and fit it between the two end points. The height of the text will be determined by the length of the space provided.

VII. Grouping Entities

The system should be able to group primatives or entities for repeated use as in the case of symbols or repeatable portions of drawings. These groups should be able to be scaled up or down and also be allowed to be broken apart or unnested for later modification. The ability to form and use groups may be one of the bigger advantages in any of the better CAD systems. A system without this capability may cause the operator to spend an inordinate amount of time recreating what has been created before. The ability to create symbols and symbol libraries is directly connected to this grouping ability.

VIII. Modifying a Drawing

Drawings should be able to be altered through different methods as the need arises. These treatments should be able to be performed on individual entities by selecting each entity desired, by the window method, where all desired objects are included in a window on the screen by the system selecting the last object drawn.

The following is a list of common edit or modify functions.

Erase - The ability to edit the drawing by deleting entities from the screen. Once removed, these entities may or may not be recalled depending on which software is being used.

Move - Entities or groups should be able to be moved on the screen by picking a distance and a direction.

Copy - Entities or groups should be able to be copied, making exact duplicates at other positions on the screen.

Array - This is the ability to duplicate an object or group in a circular or rectangular fashion any number of times. This command would be used to make rows and columns of like objects or to rotate the same object about a center point.

Mirror - This command allows the operator to create a mirror image of an object where the object is the same on both sides of a horizontal or vertical line. This allows the operator to draw only half or in some cases, one quarter of an object.

Break - This command allows the operator to remove a section of a primative. This section may be at the end of a line or arc or be in the middle of a line, arc or circle.

A note about the Edit commands:

The power of an CAD system can be determined by the extents of the modification or edit commands. This is where the real power of any system lies. If things can not be erased, moved, copied, etc. to alter the drawing to the operators needs and must be erased and redrawn, then the system is no more than an electric, high-tech pencil with probably more disadvantages than advantages.

IX. Display Options

The operator should be able to select a point of view during the drawing process. The operator must be able to zoom in or out as desired. The magnification of the drawing on the screen will allow the operator to be very precise in the selection of the desired points. This ability may also be called window in or out depending on the software package being used.

X. Geometric Generation

Most good systems will perform round and fillet operations as desired by the operator. The desired radius will be inserted by the operator and the system will perform the operation automatically when the two lines to be rounded are selected.

Most systems will also work with solid shapes and will fill these shapes on the screen. Another important task is the ability to hatch in a sectioned area using a varied number of section symbols.

XI. Layers

CAD systems should be able to work on any number of different layers. These layers may be used to place different line types on a drawing or different type objects into a drawing as in architecture where a different layer would be used for the electrical plan or the plumbing plan overlayed on top of the original floor plan. Layers must be able to be selected and turned on and off at will. If organized properly, this capability can be very useful in the development of complex drawings. Layers are sometimes referred to as levels.

XII. Dimensions

Most good systems will generate dimensions for a drawing at some level of automation. Some systems may require the operator to select the object to be dimensioned and it will compute the size of the object and position the dimension automatically. Other systems will prompt the operator for the beginning and end of a distance and the position of the finished dimension. The system will then compute the distance and place the completed dimension on the screen. This is commonly referred to as semi-automatic dimensioning.

XIII. Plotting

The final result of any system is to produce hard copy. To complete the CAD process, the operator must be able to transfer what is on the screen to a plotter or printer to produce a copy of the drawing on the screen. This can be accomplished by means of a single or multi-pen plotter or a dot matrix or laser printer. All systems will have these capabilities and these do not directly effect the methods by which a drawing is originally developed.

As in the varied amount of systems on the market, one must realize and understand that each system has its advantages and disadvantages and will not be all things to all people and applications. Each system will stand on its own merits and must be considered as an individual. When playing the comparison game and shopping around, you will begin to realize that comparing CAD systems on a capability and cost basis is like comparing apples and oranges. The final choice is the correct choice for your application.

3. Evaluation - What can it do? What can't it do? Most currently offered systems have the same basic capabilities and will suit the

comprehensive high school Industrial Arts/Technology Education Curriculum for Drafting. The more powerful the editing commands are, the more powerful the system is generally thought to be. When shopping for a system it may be most important to ask, "What won't the system do" rather than "What will the system do."

Unit 4 - Computer Graphics

A. Introduction

Computer Graphics covers a wide spectrum of applications. To define it, we can say it is the creation and manipulation of images through the use of a computer. The use of computer based imaging systems is limited only to your creativity and application of existing software to fulfill your application needs. We will try to give you insight into the application of computer graphics and where you can apply this technology to your classroom needs. Through the application of computer graphics, we hope to allow the schools programs greater scope to relate to business and industry.

Computer systems which will be looked at in terms of application will be Apple (IIe & Macintosh), IBM, and Tandy. Other systems which are compatible may be substituted for the above sytems.

Many of the high tech graphics were originally generated on computers of large mainframe systems. This has changed drastically through the technology of microcomputers. To date, the microcomputer's main limitations are processing speed and image resolution. With new developments in hardware and software, applications, processing speed, and image resolution have dramatically increased.

Currently LASER technology has enhanced graphic reproduction. LASER stands for Light Amplication by Simulated Emission of Radiation. The application of laser technology has shed a whole new light on high quality copying techniques to generate a printed image. Not only in printing are laser images used, but also projected and used on television, motion pictures, concerts, multi-media events and many other applications.

Today most laser printers produce a 300 dot per inch image, which is not quite the quality of a phototypesetter. To date, two laser printers have the quality of a phototypesetter. They are the Tegra and Data Recording System. Corporate users, newspapers, small printers (quick printers), and in-inplant printers are migrating to laser printing. Over the next few years laser printers will increase in quality. Currently there is a 300 dot per inch resolution and by the end of this year a 600 dot per inch resolution will be available. By the end of 1987 there will be available a 800+ dot per inch resolution. Once you pass 600 dots per inch you are approaching photo quality.

As you can imagine, there is a great future in graphic imaging and we hope to make everyone aware of what is on the present market so they can plan to incorporate it into the current Industrial Arts/Technology Education curriculum. Today you can invest in a laser printer connected to a microcomputer to offer a full compliment of graphic imaging for well under $10,000. This could be a substitute for an expensive phototypesetter which is more costly to operate.

B. Familiarity with Computer Graphics Composition

Graphic composition is the assembly of images for the printing medium. It can include words, lines, solid areas, photographs, symbols, illustrations, and shading.

With graphic input devices, we can put together the above items for composition. Various software is available for the selection of your type fonts and imaging. The quality of the composition results in the type of output device used.

- the output from a microcomputer to a dot matrix printer or similar printer will print a marginal quality image to reproduce.
- the output from a microcomputer to a daisywheel printer, an ink jet printer, a thermal transfer printer, or a plotter will print a higher quality image.
- the output from a microcomputer to a laser printer will print a near photo quality image.
- the output from a microcomputer to a phototypesetter will print the highest quality image.

- there is also output from a phototypesetter terminal to the phototypesetting processor to obtain an image of the highest quality.

A listing of input/output devices, processing devices, storage media, and software are outlined in the section of the guide "Principles of Computer Systems."

C. Applications

Generating and editing text and graphics for print media and video media are accomplished through hardware and software applications.

VIDEO SCANNING techniques are achieved through cameras and projected artwork on a screen and then output to a video screen or printer. Scanning can occur from a printer and digitized back to a monitor.

Printed media is accomplished through using input devises listed below:

- keyboard
- scanner
- light pen
- joystick
- digitizer
- trackball
- mouse

It can be output in many ways:

- dot matrix
- ink jet
- daisy wheel
- monitor
- laser
- thermal transfer
- plotter
- modem/telecommunications

Listed below are various applications of computer graphics:

- typesetting
- scanning
- CAD
- shading
- desktop publishing
- video separating
- animation
- freelance artwork
- 3-D drawing
- sketching
- wireframe drawing
- color separating
- business graphic applications

D. Merging Text and Graphics

Merging text and graphics is achieved with various software programs. We are able to perform desk-top publishing in combining all facets of the printed image, using the computer. We are able to insert photos, graphs, line drawings, illustrations, and other media to the printed page. Electronic publishing is now an affordable part of a graphic designers library. If we look at pagemake-up for personal computers we will see two dominant camps; one being APPLE and the other IBM. Whether designed for the APPLE or the IBM, most of today's pagemake-up programs allow you to create text and graphics with separate software, and then place those files into the pagemake-up program.

A layout is created which can be stored for later use or place the text and graphics while specifying sizes, fonts, leading and other functions. Most programs have word processing and graphics capabilities for the alternation of text and images after placement. After placing the elements, the user can preview the page. Some programs produce a mock-up where better programs offer a "What You See Is What You Get" mode that displays text and graphics as they will appear on the printed page. Once the designer is satisfied with the layout, hard copy can be produced. Proofs can be printed out on a dot matrix printer and then final output can be sent to a laser printer or a phototypesetter to create camera ready copy. Some packages support telecommunications, so the finished product can be sent over phone lines to a typesetting service or from the designer to the in-plant. The school can use a microcomputer and modem and send for type-set copy over the phone lines to be used for graphics applications. A disadvantage to this is the turn-around time which is generally longer. There are large printers within the state that do provide this service.

E. Hardware Requirements

1. Computers: Any of the available micros can be used:
    - a. Apple (IIc, IIe, Macintosh, Macintosh Plus)
    - b. IBM (PC, XT, AT)
    - c. Tandy (1000, 2000, 3000)

        d. Compatibles

    2. Input Devices

        a. Digitizing tablets

        b. Scanners

    3. Output Devices

        a. Laser printer

        b. Dot matrix printer

        c. Monitor display

F. Software - Commercial Packages

There are at present literally dozens of software packages available for each of the commonly used microcomputers.

G. Graphics Through Programming

With an ability to program in BASIC, you can design many graphic representations that can be used in printed form or used strictly in the art form. Software can be any standard BASIC program for the microcomputer.

Resourse books that have many programs in basic are School Shop, Industrial Education, and Iowa University book of programs in BASIC COMPUTER PROGRAMMING.

H. Desktop Publishing and CIP (Computer Integrated Publishing)

A new direction in printing heads for the future - it is the transfer of ideas and information using symbols on media --- not the mechanicalistic "Marks on Paper Context of the Past."

Desktop publishing is the ability to converge three tools: personal microcomputers, printers, and page-makeup software capabilities of transforming computer documents into format that looks published. This can eliminate the composition plant or office entirely, by one person who can, for less than $10,000 turn out a product that looks typeset.

A desktop publishing system includes:

- systems to integrate text and graphic elements
- full pagination
- output to laser printing or photocomposition
- shared databases for systems editing and composition work station
- input and output devices and communications interfaces
- integration of word processors, computers, scanners, CAD systems, modems, and media converters
- typographic quality
- graphic display workstations
- sharing peripherals as scanners, disks, tape drives, and printer
- multi-channel background processing
- font generation

In-plant printing shops are currently interested in the utilization of desk-top publishing and electronic publishing.

International Resource Development predicts that electronic printing will make the in-plant print shop obsolete by 1994.

I. Graphics Signmaking Unit

Computers are currently being used in the art and signmaking business. Microcomputers, digitizing pads, software and a self-contained processing unit can produce a finished sign in minutes, where a talented signmaker would take hours to complete. These machines would fit well in to a Industrial Arts/Technology Education lab.

Unit 5 - CAM/CIM: Computer Aided Manufacturing
Computer Integrated Manufacturing

A. Concepts

1. CAM - Computer Aided Machining or Computer Aided Manufacturing is any machine process which was traditionally done by a craftsman or skilled operator and is now being done by a computer microprocessor equipped machine which controls the operations being performed.
2. CIM - Computer Integrated Manufacturing is any manufacturing process which is coordinated by a central computer which unites the different areas of an industry such as the design, inventory, machine process, quality control, inspection and transportation of a product.
3. As the adaptation of the microprocessor to the machine tool industry has evolved, more and more machine processes are being done with the assistance of the computer. Computer aided manufacturing is a broad based portion of today's industries, in that an ever increasing number of industrial processes are currently being done with the assistance of computers. Robots are finding a place in some of the larger industries doing tasks such as pick and place operations, assembly, welding, and materials handling. Computer Aided Machining is what we most often identify the term CAM with. This is the

uniting/adaptation of a computer and a machine tool, such as a lathe or milling machine, which can be programmed to perform repeatable machine processes and tool movements through the use of coordinate points and tool path design programs. Other variables in the machining process also controlled by the computer, maybe: tool travel speed, R.P.M. (revolutions per minute) of the work on the lathe, and the tool on a miller. On some more sophisticated machines, the selection of the proper tool for the task at hand can also be controlled through computer programs and programmable tool turrets.

B. Goals

1. Familiarity with the concepts of CAM/CIM
    a. Capabilities of CAM/CIM
        1. Increased coordination of work processes
        2. Lower raw product inventory
        3. Finer quality control capabilities
        4. Ease of monitoring work processes - start to finish time study analysis
        5. More consistent finish product
    b. Programability of today's machines
        1. X, Y, Z axis programability
        2. Repeated processes
        3. Canned programs - packaged movements such as threads, facing, radii turning, etc.

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        4. Longer tool life
        5. Combinable looped processes
        6. Programmable stops for tool or material changes
    c. Advantages of CAM
        1. Accurately repeated processes
        2. Increased quality control
        3. Less skilled operator input
    d. Advantages of CIM
        1. More coordinated processes in the manufacturing environment
        2. Less lead time
        3. Reduced raw product inventory
        4. Reduced finish product inventory
        5. Closer relationship between design and manufacturing forces
        6. Increased availability of manufacturing data analysis i.e. time study, quality control analysis, product analysis
2. Develop new approaches to the manufacturing environment
    a. Increased flo-chart use in multi-process products
    b. More organized layout of machine placement in shop
    c. Reduced tooling knowledge in operator
    d. Increased need for programming analysis in

operator

- e. Operators become less active participants in the operations being performed
  - 1. Observer vs. skilled operator/machinist
  - 2. Set-up and program analyst vs. hands-on
- 3. Understand connections with other areas
  - a. Increased involvement and interaction with engineering department
  - b. Closer monitoring of inventory: raw and finished
  - c. Increased availability of data for production analysis
- C. Application (CAM)
  - 1. Machine types
    - a. 2-axis: lathe
      - 1. Turning
      - 2. Facing
      - 3. Threading
      - 4. Canned processes - thread cutting cycle end facing, in-cut-out-return loop, radii cutting loop, etc.
      - 5. Coordinates (x and y)
      - 6. Program codes and tool path plotting
    - b. 3-axis: milling machine
      - 1. Coordinates (x, y, and z)
      - 2. Program codes and tool path plotting
      - 3. Tool changes

2. Programming a CNC machine
    a. materials suited to the capacity of the machine
    b. Tool movement codes (G codes) - some examples
        1. G-78, threads
        2. G-01, directional movements
        3. G-02, radius - outside
        4. G-03, radius - inside
        5. G-84, rectangle movement - canned program
    c. Canned operations
        1. Four motion cut path - rectangle (in to work, cut, out and return to zero)
        2. Fillets and rounds - inside and outside radii cutting
        3. Threads and threading processes
        4. Facing operations
        5. Programmable tool changes - turret equipped machines
3. Executing a program
    a. Design program
        1. Shape of desired finished product
        2. Material to be used
        3. Rate of feed
        4. Movement codes
        5. Set speed of work or tool R.P.M.s
        6. Insert and set-up stock
        7. Insure safe operation - install and secure guards

8. "run" program

D. Hardware

1. CNC lathe, mill, etc.

   The lathe and the vertical, multi-axis miller (Bridgeport type) are currently the machine tools which are being produced in CNC form. These may be equipped with multiple tool turrets (lathes) or have programmable stops for tool changing.

2. Self-contained unit (dedicated) vs. separate component system (using a PC)

   Most industrial quality machines are dedicated and use integrated software and microprocessors which are set up to perform the tasks which the machine is designed for only. Some smaller, educationally based machines are designed to operate from a personal computer through the use of standard codes and also allow the operator to use the computer for other tasks such as word processing, spread-sheeting, CAD, etc. There are at present several smaller than industrial scale "dedicated" CNC training machines that would also be suited to an educational application.

3. System requirements
   a. Computer system
   b. CNC interface
   c. Machine tool
4. Safety/Hardware

All guard and safety precautions must be used in CNC operation. The operator's role as an observer removes him one "step" from direct contact and control of the machine tool and new hazards arise with the infusion of CAM. Most machines are equipped with an emergency stop control or panic button to allow for these situations.

5. Accessories
    a. Programmable turret allows for tool changes which can be programmed without stopping the machining operations
    b. Tool path graphics allows the operator to view tool path before actually "running" the program and allows the operator/programmer to edit or add necessary steps
    c. Printer, monitor allows the operator to watch and analyze the program as it is inserted into the computer. Some video packages allow the operator to view the tool path in line form on the screen before every striking the tool to the work piece. Prevention of tool crash is possible with this option, also.

E. Software
    1. Dedicated software packages
        a. Single usage
        b. Reduced flexibility

        - c. Increased reliability
        - d. Less operator input
    - 2. Industry standards (EIA RS274D)
    - 3. Integrated systems
        - a. Design - Manufacturing link - This link-up allows the engineer to dump his design data directly from a CAD system to a programmable machine. The design data is then translated to numerical code to control the operation of the machine.
        - b. True CAD/CAM linkup - The sterile hookup of a CAD system to a CNC machine to directly use CAD generated information to produce a product on a CNC operated/controlled machine. These linkups are idealistic at best and may present some safety hazards. In reality, these pure hookups are not presently being used on any wide scale. The possibility does however exist.
        - c. Testing and quality control assurances

F. CIM Applications

- 1. Design layout- CAD
- 2. Design analysis - research and development
- 3. Manufacturing engineering - testing and analysis
- 4. Facilities engineering - plant layout
- 5. Fabrication automation - robots

  a. Welders
  b. Cutters - laser or torch
6. Assembly automation - robots
  a. Pick and place only
  b. Multi axis assemblers
  c. Multi task assemblers
7. Material handling
  a. Conveyors
  b. Automated fork trucks (John Deere Inc.)
  c. Other computer automated materials handling
8. Industrial engineering
9. Quality assurance
  a. Design testing
  b. Product testing
  c. Manufacturing process evaluation

Unit 6 - Microprocessors

A. Concepts

1. Definition

   A microprocessor, or microprocessing unit, (MPU) is a computer central processing unit (CPU) built as a single tiny semiconductor chip (integrated circuit) or as a small number of chips. It contains arithmetic and control logic circuitry necessary to perform the operations of the computer program.

2. Role of the microprocessor in relation to the computer

   a. CPU has other support chips and storage devices. In addition to the CPU, a basic microcomputer requires a read-only memory (ROM) to store the computer program or instructions, a random-access memory (RAM) to store temporary data (the information to be acted upon by the computer program), and an input/output (I/O) IC to make the system compatible with peripheral equipment.

3. Types of microprocessors

   a. Types of busses - Three major busses link the memory, CPU, and I/O ports

      1. Address bus - The CPU sends out on the address bus the address of a memory location that is to be read from or written into. The address bus is also

used by the CPU to select a particular input or output port.

2. Data bus - The data bus is bidirectional. Depending on what operation is being performed, data may be coming from or going to the CPU, memory, or the I/O ports.
3. Control bus - The control bus carries signals which enable memory or I/O for proper operation. Examples of these signals are: memory read, memory write, input read, and output write.

b. Information handling capability

1. Eight bit processors - The typical eight bit microprocessor is capable of understanding and performing approximately 256 different instructions and accessing 65,536 address locations.
2. Sixteen bit processors - Sixteen bit microprocessors are capable of working with 16 bit instruction words on 16 or 32 bit data buses so that they can access megabytes of memory.

c. Series/Classification

1. 6502 Series - the 6500 series at present has 10 versions that differ in package size, addressing capability, and the presence or absence of internal clock

logic. The 6502 has an internal clock generator, one 8 bit accumulator, an 8 bit stack pointer register, two 8 bit index registers, x and y, and a 8 bit status register. It is currently used in the Apple II family of computers. The 65C02 is used in the IIc and enhanced IIe.

2. 8080 Series - The 8080 microprocessor is an 8 bit CPU. It has an 8 bit accumulator, a temporary registor, a 16 bit stack pointer, a program counter, and an address latch. It is currently used in the IBM-PC and compatibles.
3. 68000 Series - The 68000 is a 16 bit processor. It has a 23 bit address bus, and a 16 bit data bus. The 68000 is capable of addressing up to 16 megabytes. The 68000 has eight 32 bit general purpose register, seven 32 bit address registers, and two 32 bit stack pointers.
4. Other microprocessors are continually being introduced with different and more powerful capabilities. It is expected that the above list will be somewhat dated as this is printed.
5. Clock Speed - The clock is a device which sends timing pulses to synchronize the

actions of the microcomputer. Each instruction that the microprocessor executes requires a different number of clock cycles. If you know the number of clock cycles for each instruction and the time for one clock cycle, you can calculate the time needed to execute each instruction. Common clock speeds are:
1 MHZ, 4.77 MHZ, 8 MHZ

B. Goals

1. Computer Architecture - A computer consists of three major parts
   a. Memory section - The memory section usually consists of ROM, RAM, and magnetic disc or tape. The memory is used to store programs or instruction sequences which the computer will execute. Memory is also used to store data the computer will process.
   b. Input Output/Interface section - This section allows the computer to interface with the outside world. An input/output port allows data from some outside source (keyboard, disc drive, transducer) to be taken into the computer under the control of the CPU.
   c. CPU section - The CPU contains circuitry that performs control functions, ALU (Arithmetic Logic Unit) arithmetic and logic functions,

some registers to handle address information, data, control codes, and an address program counter. When a program is executed the CPU sends out to the memory location of the code for the first instruction to be executed. At the same time a memory enable signal is also sent out. The instruction code comes into the CPU from memory and is executed. After each operation the program counter is incremented to the next address location.

2. System architecture - Microprocessor architecture is the arrangement of the ALU, counter's, registers, etc. found within the microprocessor. There are two commonly used methods to show microprocessor architecture. The block diagram which shows all the internal resistors, counters, etc. and the program model which shows only the pointers, accumulator, register, and counter.
3. Storage
   a. Word size - The microprocessor uses a binary system to operate. The combination of binary digits is used to make up a word. There are two types of words: data words and instruction words. Data words contain the information to be processed and instruction words which cause the computer to execute

a particular command. Most microprocessors use 8 bit words but there are systems that use 4 bit and 16 bit words. The longer the word length the more instructions the CPU will be capable of handling and the more varied the addressing modes.

b. Registers - Registers are storage areas within the microprocessor. They are filled, emptied, and combined using the program instructions. Registers are used for temporary storage of data and addresses for use during the operation of the program.

c. Main memory - The main memory is the section of the computer which stores instructions and data. Each instruction or data byte is assisgned a unique address used by the microprocessor when fetching or storing information. The main memory is made up of ROM (read only memory) and RAM (random access memory). The information stored in ROM is a permanent part of the computer and will remain intact when the computer is shut off. The information stored in RAM is temporary and will be lost when the computer is shut off.

d. Auxiliary storage - Auxiliary storage supplements the microcomputer's ROM and RAM memory. There are several types of auxiliary storage systems available for microcomputers. Some of the most common are cassette tapes and floppy disks.

4. Processing
   a. Instruction set - An instruction is a set of bits that defines a microprocessor operation and is a command understood by the microprocessor. Instructions may move data, do arithmetic and logic functions, control I/0 devices, or make decisions as to which instruction to execute next.

      The instruction set is comprised of the general purpose instructions available with a given microprocessor. In general different microprocessors use different instruction sets.

5. I/0 communication - Microcomputers communicate with external devices through input and output ports. These ports require special hardware that usually accept and transmit information in parallel or serial form.
   a. Communication paths
      1. Parallel - When the computer receives information in a parallel form all the bits that comprise a word are sent simultaniously.

2. Serial - When the computer receives information in a serial form each bit is sent individually until the complete word has been received.

b. Control

c. Interrupts - An interrupt is a process usually initiated by an external device which causes the microprocessor to interrupt a program in progress, for the purpose of transferring information between that device and the computer.

6. Digital logic - Digital logic is a system which operates with two discrete states. These are represented by the digits 0 and 1 and correspond to the "off" (0) and "on" (1) condition of the semiconductors. The input and output of a device will be one of these states. Since digital logic operates in a two digit system the binary number system is used to represent its quantities. While the computer uses digital information exclusively most external devices have continuously varing values (analog). If we wish to interface these devices with the computer we will require a device to change these analog valued into digital form. These devices are called analog to digital converters.

The study of digital logic includes the logical operators known as gates. These include AND, OR, NOR, NAND, Exclusive OR etc. In addition, timing and counting operations would be covered.

7. Microcomputer Interfacing - Interfacing is the circuitry required to link a peripheral device to the computer.
   a. Cabling and Connectors
   b. Modems - Modem which is short for modulator-demodulator is a device used to send digital information betwen computers by means of the telephone lines.
   c. Series and parallel paths - See communication paths above
8. Applications - The microprocessor itself is the heart (brain?) of all other computer systems from a digital wrist watch to the computer itself. It is difficult to find an area where the microprocessor has not been pressed into service. Here are but a few varied examples:
   a. All computers of every type
   b. Robotics
   c. CNC machines
   d. Automotive systems
   e. Military systems
   f. Photography
   g. Environmental control

    - h. Satellite communications

9. Hardware
    1. Chip types - Most microprocessors are encased in a dual-inline-package (DIP) with either 40 or 64 pins. These IC's are categorized as large scale (LSI) or very large scale integrated circuits (VLSI). A new method of integrated circuit packaging called surface mounted device technology is making smaller chip packages possible.
    2. Support Chips - There are a variety of support circuits that work with the microprocessor. Examples of these are RAM chips, ROM chips, Timers, I/O chips, logic chips, voltage regulators, math-coprocessors, etc. All these support the operation of the microprocessor and together form a microcomputer.
    3. Microprocessor trainers - Numerous trainers are available for programs in microprocessor study. These bread-boarded computers allow first hand study and experimentation with many areas. Among them are:
        - a. Microcomputer architecture
        - b. Machine and assembly language programming
        - c. Internal computer operation
        - d. Interfacing

Unit 7 - Robotics

Industrial robots are fast becoming the hands and eyes of the production floor. Improving not just productivity but quality control for companies that produce goods. The job of management, just as quickly, is becoming the monitoring and maintenance tool of information between the various components of an automated system. As s key component of an automated system, robots merit special attention; for they can do simple repetitive jobs more steadily, more reliably, and more uncomplainingly than humans. Current and future trends in their design, capability, and application serve as indicators of overall automation activity in the workplace. In the past 10 years robotic manufacturing has become increasingly commonplace in world production facilities, enjoying a very bright future in the coming decade. Along with this expected increase in growth, changes are anticipated in the nature of production employment, its various support groups as well as educational standards for members of the work force.

Robots consist of two major component systems. The first, manipulators or moving parts, are comprised of arms, wrists, and hand elements. While the second, the control system, can range from the simple mechanical switch or stop to the more complex computer type control; which allows programmable memory, accuracy in movement, and the ability to interface with other control.

A. The majority of robots, excluding custom-designed robots, fall into one of four major categories.

   1. Articulated (jointed) - These robots have rotary joints in several places along the arm that roughly correspond to the shoulder, elbow, and wrist in humans. Usually the entire unit is mounted on a rotary base. Robots of this type are by far the most popular in today's market.

   2. Cartesian (rectilinear-coordinate) - These robots are mounted on a fixed base. All arm motions of the manipulator are in a straight line, either in-out, up-down, or side-side. Even though a pivoting wrist joint may be provided, the unit itself conforms to either a cube or a rectangular solid.

   3. Cylindrical - The manipulator or moving parts are usually a vertical column with a horizontal arm mounted on a rotating base.

   4. Spherical - Mounted on a rotatry base and resembling the turret of a tank, the arm cannot only extend and retract, but is pivoted so it can swing vertically allowing rotary motion about a horizontal plane.

B. The specification for an industrial robot must exclude any requirement that cannot be achieved in practice. This being the case, every specified feature of a robot must be within the scope of contemporary engineering knowledge and practice. The following are common characteristics essential to any robot that is intended to replace a man or woman at a machine station. Robots must have:

1. A hand which can grip or release the workpiece
   a. Mechanical grippers
   b. Hooking on to a part
   c. Electromagnets
   d. Vacuum cups
2. An arm which can move the hand in three planes
   a. x-axis
   b. y-axis
   c. z-axis
3. A wrist for the arm, with three articulations
   a. up-down
   b. side-side
   c. circular
4. Sufficient limb power to lift and maneuver the workpiece
5. Manual controls with which a person can operate the limb
   a. Pendant control
   b. Keyboard control
6. A memory, which can record manual operations
   a. CPU
7. Automatic means for controlling the limb from the memory

            - a. CPU
        - 8. Ability to function at a speed not less than that of a person
        - 9. Reliability
    - C. Basic applications range from but not limited to
        - 1. Assembly
        - 2. Manufacturing
        - 3. Material handling (especially in a hazardous environment)
        - 4. Pattern recognition
        - 5. Artifical intelligence
    - D. Hardware
        - 1. Robot systems
            - a. Basic - kits for line tracer and programmable robots
            - b. Complex - pick, place, and palletizing
            - c. School application - training units (Rhino or Hero types)
        - 2. Input Methods
            - a. Input-output, programmable material
            - b. Teach pendant
            - c. Keyboard
            - d. Environment sensors

Unit 8 - Telecommunications

Telecommunications is an area which has blossomed in the last few years. The advances in technology as applied to telecommunications have expanded right along with that of the microchip and microcomputer. The many diversified mediums and modes provide valuable uses in any classroom.

The equipment needed to begin the use of telecommunications is easily understood. The equipment needed can be divided into three parts: 1) transmission mediums, 2) modems, and 3) microcomputers.

A. Transmission - Mediums

1. Telephone lines - Telephone lines simply need a connector block in the classroom to which a modem can be connected. The use of telephone lines enables one to access the commercial services and bulletin boards, free public bulletin boards, as well as other microcomputers and mainframe computers. All of the modes discussed under Radio Waves can be used over the phone lines.
2. Radio Wave - Radio waves reception and transmission requires a radio receiver or transceiver and a good antenna. The only need for a transceiver would be for the transmission data by amateur radio. A good general coverage receiver opens up many excellent and exciting possibilities including amateur, government and

commerical sources. The modes possible to be used with and displayed on a microcomputer include:

- a. Teletype, both Baudot and ASCII
  - 1. U.S. Weather Service
  - 2. News wire service
  - 3. International and amateur message traffic
  - 4. Communications with other amateur radio stations
- b. Facsimile
  - 1. Weather maps from U.S. Weather Service and the U.S. and Canadian navies
  - 2. Other experimental transmissions
- c. Slow scan television
  - 1. Amateur radio
  - 2. Space probes

3. Fiber Optics - Fiber optics can transmit all of the above modes as well as analog signals such as voice and music. The fiber optic materials is inexpensive in a quality which is quite adequate for classroom use. In the absence of radio equipment, the principles of transmission can be demonstrated with fiber optics. Inexpensive kits are readily available to build fiber optic transmit and receive terminals.
4. Lasers - Lasers can be used much the same as fiber optics. Anyone fortunate enough to have

a laser should be able to modulate the laser with the digital information coming from a modem.

B. Modems

Modems (MOdulator/DEModulator) are the interface between the transmission medium and the computer. The digital computer data is generally sent over the transmission medium as audio tones or as frequencies which can be converted into tones. It is the job of the modem to convert these tones into electrical pulses which can be understood by the computer. Conversely, outgoing data from the computer is converted to corresponding tones by the modem before entering the transmission medium. There are many designs around for the fabrication of modems and there are commercially available modems at very modest prices. One must be sure that the modem being purchased or built will supply the proper protocol for the originating computer, the receiving computer, and the transmission medium. Protocol includes: Baud rate (speed of transmission) i.e. 300 baud most common, 1200 baud also in use; tones and frequency shifts i.e. Bell 202; and stop bits and parity bits. Most terminal software, which is necessary in addition to and which may not be part of the modem purchase, usually will have the ability to set the particular protocol parameters.

C. Microcomputers

Microcomputers of all descriptions can be fitted with modems and used for the different types of operations. Some makes and models will be easier than others to outfit. Many modems will operate through game paddle ports, while others will have to plug into computer slots or other special ports. Terminal software which is compatable with the particular modem will have to be written or purchased by the user.

Unit 9 - C.A.I.: Computer Assisted Instruction

A. The use of the computer and C.A.I. can be a very effective instructional tool in skill development. Whether it is a drill and practice, simulations, tutorials or testing, the student is provided with interesting and motivating programs. The student is provided with numerous problems at an individual and appropriate level of difficulty along with an instantaneous feedback to let the student know his/her progress.

B. Types of C.A.I.

1. Simulations
    a. Allows students to explore concepts by playing roles
    b. Simulations may cover a wide range of roll playing concepts
        1. General contractor
        2. Lumber salesman
        3. Energy conservation
        4. Power plant operator
    c. The computer acts on students decisions and lets them know the results
2. Tutorials
    a. The use of the computer to teach specific subject matter
        1. Students need review
        2. Students explore new materials

            - 3. Teacher not available
            - 4. Supplements to your course
            - 5. Provides frequent checks on learners progress
- 3. Drill and practice
    - a. Teacher does the teaching; computer's role is to reinforce what has been taught
        - 1. Further development of skills in computation
            - a. Measuring
            - b. Work with board feet
            - c. Work with fractions
            - d. Work with decimals
        - 2. Further development in proper use of hand tools and power tools
        - 3. Development of SAFETY skills
        - 4. Testing
            - a. Material generation
                - 1. Teacher input
                    - a. Store objectives
                    - b. Store test objectives
                - 2. Computer output
                    - a. Print tests on worksheets for individual students based on teacher objectives
                    - b. Present tests specific to the skills and concepts in various formats

            1. Word find puzzles
            2. Game format
        - c. Analyze the students' weaknesses
        - d. Prescribe remedial work

5. Video/computer interface
    - a. Computer interface with video laser disk
    - b. Computer keyboard used as feedback unit
    - c. 12 inch laser disks available for various instructional areas

Unit 10 - Data Management and Other Classroom Utilities

Perhaps one of the greatest benefits of the computer's time saving and efficient manner in which it allows one to manage tremendous amounts of data. School systems are beginning to use the power of the computer in such tasks as scheduling and attendance tracking. Stop and think about all of the data that a teacher in Industrial Arts/Technology Education must manage during the year. Pressing the computer into service will ease this burden and help you accomplish these many necessary tasks better, faster, and more efficiently than ever before. What follows is a sampling of suggestions for classroom data management.

A. Budget - "Spread sheets"
   1. Equipment money allotted
      a. Amount spent
      b. Vendors
      c. Equipment purchased
   2. Supply money allotted
      a. Amount spent
      b. Vendors
      c. Supplies purchased
   3. Petty cash
   4. Future purchases

B. Data Bases
   1. Student names, addresses, grade level
   2. Project, grade

3. Attendance
4. Supply inventory

C. Word Processing

1. Report writing
2. Lesson planning
3. Test making
4. Information sheets (Instruction material)

D. Grading Packages

1. Packages available for test grading and averaging
2. Teacher input
   a. Students' grades
3. Compuer output
   a. Students' grades
      1. Letter
      2. Number
   b. Students' average
   c. Class average
   d. Statistical analysis of grade information
   e. Progress reports

E. Test Generation Packages

F. Graphing Packages

1. Allows students to utilize the computer as a tool to graph experiemental data i.e. electronics, power technology, materials testing etc.

Unit 11 - Careers

While other businesses are laying off, there are thousands of openings in the computer profession that can be filled by people of almost any age or background who are not necessarily scientists or mathematical geniuses, or even college graduates. The field is exciting with diversity and rapid changes that make it appealing. The changes in the work force can best be summarized with these government projections:

Computer in Use

1970	1980	1990
100,000	600,000	?

Growth in Computer Employment in United States

1970	1980	1990
676,000	1,455,000	2,140,000

Projected Future Growth in Next Decade

Jobs in Computer Field in General	20%
Jobs in Computer Operator	25%
Jobs in Computer Programmer	55%
Jobs in Computer Service Technicians	105%

A. Computer Technicians (also called service technicians, customer engineers, field engineer, etc.
   1. Specializes in a particular system or type of repair
   2. Performs preventive maintenance
   3. Solves operating problems (trouble shooting)
   4. Schooling - two year technical college or private

post secondary school

B. Computer Programmer - Develops instructions to tell a computer what to do
   1. Responsibilities - Write automated procedures for the computer
      a. Program coding - The development of a step-by-step list of "commands" which will produce the specified results (a report or form)
      b. Documentation - Written explanation of what the program does
      c. Implementation - Reviews the operation of each program to see if program is working as it was conceived
   3. Training - Testing to determine aptitude, concentration, determination, problem-solving ability, and comprehension
   4. College graduate preferably computer science major

C. Computer Operator - The person doing "production work" (entering data, operating equipment, outputting the results)
   1. Training varies depending on the less than particular application

D. Careers in Related Areas
   1. Manufacturing (large area, everything from steel to soap)
      a. Acquire raw material

    - b. Combining raw material with each other to process a finished product
    - c. Packaging, selling, inventorying, and shipping
    - d. Collecting money and paying bills

  The job of computers in manufacturing is to help solve problems in each of the above areas. Increasingly computers or related technology is being given a more active role i.e. CAM/CIM

  2. Publishing and Communications
      - a. Maintain mailing lists including prospective book and magazine subscribers
      - b. Word processing for the preparation of copy for books and magazines
      - c. Electronic communications involving transmission of information and correspondence of all kinds
  3. Transportation (on ground, in the air, by rail or water)
      - a. Bring together shipments and carriers
      - b. Programmer designs systems to match shipment with modes of transportation
      - c. Computers used in toll-collection
  4. Construction - Designing buildings and other structures; creating B/Ps and estimating costs
      - a. Using computerized graphic for solving design problems

E. End Users - When computers are sold, from giant mainframes to personal microcomputers, they become the property of end users

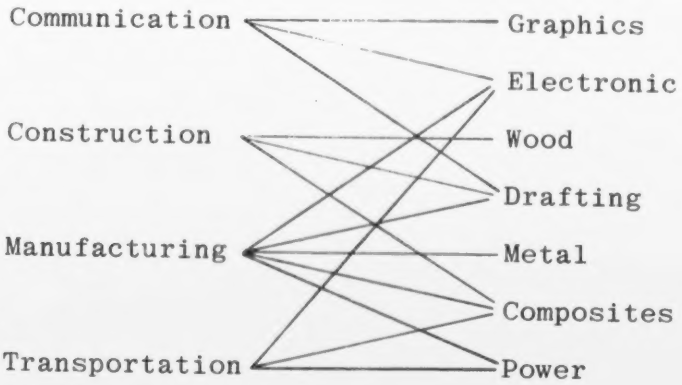
a. System analysts - Analyze a business entity, ascertain its goals and problems
b. Programmer - Convert the instructions given by analysts into a code compatible with computer system at hand
c. Operators - Actually run the machines, feeding in data, tapes, diskettes, and getting out reports labels and other information
d. Technicians - Needed to make sure the computers operate at optimum level of efficiency and to correct malfunctions
e. Data Entry Personnel - Take raw information and enter it into the computer system

These are but a sampling of computer related careers. Indeed it would be difficult to find many careers which are not in some way affected or altered by computers. A breakdown of the fields where computer people are found follows:

Services	29%	Government	10%
Manufacturing	28%	Communication & Transportation	6%
Finance & Insurance	13%	Others	2%
Retail & Wholesale	12%		

IMPLEMENTATION SUGGESTION MATRIX

The matrix presented in this section represents an effort by the committee to suggest a wide variety of possible ways computer use might be integrated into the courses you teach. The areas listed are representative of the areas of Industrial Arts/Technology Education commonly taught. The eight areas listed are reflective of and may be categorized by the four areas of Technology Education as suggested in the publication "Technology Education: A Perspective on Implementation." The correlation might be as follows:



The committee takes the view that the best use of computers in Industrial Arts/Technology Education lies in the utility they can provide the students, as computers do in the real world of business and industry. That is, to accomplish a given task faster, more accurately, and with greater dimension than possible before. Therefore, most of the listed implementation suggestions are utilitarian in nature. There is room in any program, however, for quality simulation or tutorial packages some of which are also suggested.

Many of the suggestions require commercially available software; while some are available in the public domain. Other suggestions amy be implemented by adapting generic software such as spread sheets, data bases or word processing. This list is by no means intended to be complete, final or restrictive in any way! Quite the contrary, it is hoped that you will try some of these suggestions, search and experiment on your own and share with your colleagues in order that a list such as this might expand ten fold.

	GRAPHICS	METAL	COMPOSITE	PLASTICS	WOOD	POWER	ELECTR	DRAFT
ROBOTICS		◆				◆	◆	◆
CNC MACHINES/PROGRAMS		◆			◆			
CAD	◆	◆	◆	◆	◆		◆	◆
COST ESTIMATING	◆	◆	◆	◆	◆	◆	◆	
LAYOUT/PATTERN DEVELOPMENT	◆	◆	◆	◆	◆		◆	◆
PLAN MODIFICATIONS	◆	◆	◆	◆	◆		◆	◆
MATERIALS CALCULATIONS	◆	◆	◆	◆	◆	◆	◆	◆
MATERIALS TESTING & IDENTIFICATION		◆	◆	◆	◆			◆
DATABASE OF :								
Project Information	◆	◆	◆	◆	◆	◆	◆	◆
Design/Blueprints	◆	◆	◆	◆	◆	◆	◆	◆
Bills of Materials	◆	◆	◆	◆	◆	◆	◆	◆
Inventory	◆	◆	◆	◆	◆	◆	◆	◆
Supplies	◆	◆	◆	◆	◆	◆	◆	◆
SAFETY TESTING	◆	◆	◆	◆	◆	◆	◆	
TOOL/MACHINE NOMENCLATURE	◆	◆	◆	◆	◆	◆	◆	◆
SIMULATIONS	◆	◆	◆	◆	◆	◆	◆	◆
RESIDENTIAL COST ESTIMATION					◆		◆	◆
TYPESETTING/COMPOSITION	◆							
GRAPHING EXPERIMENTAL DATA		◆	◆	◆	◆	◆	◆	
PHOTOGRAPHIC CALCULATION	◆							
SCHEMATIC/PRINTED CIRCUIT DESIGN	◆						◆	◆
PROGRAMMING		◆			◆		◆	
ENGINE DIAGNOSIS/TESTING						◆		
ROCKETRY FLIGHT ANALYSIS		◆				◆		◆
ARCHITECTURAL DESIGN					◆			◆
2*D DRAW & DESIGN	◆	◆	◆	◆	◆	◆	◆	◆
3*D DRAW & DESIGN	◆	◆	◆	◆	◆	◆	◆	◆
POWER CALCULATIONS & ANALYSIS						◆	◆	
WORD PROCESSING	◆	◆	◆	◆	◆	◆	◆	◆
FONT DESIGN INDEX	◆							◆
PHOTO EXPOSURE	◆							
PHOTO DEVELOPMENT	◆							
TOOLING VARIABLES		◆	◆	◆	◆			
TOOL PATH GRAPHICS	◆	◆			◆			◆
PRECISION MEASUREMENT		◆	◆	◆		◆	◆	◆
BASIC MEASUREMENT	◆	◆	◆	◆	◆	◆	◆	◆

	GRAPHICS	METAL	COMPOSITE	PLASTICS	WOOD	POWER	ELECTRICAL	DRAFT
TOOL MAINTENANCE	◆	◆	◆	◆	◆	◆	◆	◆
FOUNDRY & CASTING CALCULATIONS		◆	◆	◆				
WELDING & HEAT TREATING		◆	◆	◆				
ALLOY COMPOSITION		◆				◆	◆	◆
DRILL SIZE CONVERSIONS		◆	◆	◆	◆			◆
FASTENERS		◆	◆		◆			◆
FLUIDICS						◆		
HYDRAULICS						◆		
PNEUMATICS						◆		
MECHANICAL POWER TRANSMISSION						◆		
GEARS						◆		
BELTS						◆		
PULLEYS						◆		
AERODYNAMICS						◆		◆
POWER GENERATION SIMULATION						◆	◆	
ENERGY CONSERVATION SIMULATION						◆		◆
COMPONENT COLOR CODING							◆	
CIRCUIT TESTING PARAMETERS							◆	
SHAPE/SYMBOL LIBRARIES	◆	◆	◆	◆	◆	◆	◆	◆
METRIC / ENGLISH CONVERSIONS	◆	◆	◆	◆	◆	◆	◆	◆

HARDWARE SYSTEM CONFIGURATIONS: FOR GENERAL USE COMPUTER STATION

Computers and their peripheral hardware have undergone rapid and drastic price and capability changes in the last several years, and will probably continue to do so in the future. Consequently, any attempt at pricing systems or identifying models would be futile as the information would be out of date by the time it was printed!

Instead, this section is presented in four parts which outline system components and requirements as three levels with a list of suggested accessories. Which level you choose will be determined by a number of factors including: budget, application, student and program level, etc. Whenever possible try to purchase with an eye toward the future to avoid short sightedness or short term obsolescence.

It is suggested that you consult with a number of sources when specifying and purchasing systems. These resources include: your local school district's computer hardware and software specialists, local computer store, area equipment vendors, and reliable mail order companies, as well as articles and reviews in appropriate periodicals.

A. Low Budget System

   1. Computer
   2. One floppy disk drive
   3. Monochrome monitor

    4. Printer interface
    5. 80 column card
    6. 64k - 128k RAM
    7. Joystick/paddles

B. Medium Budget System

    1. Computer
    2. Two floppy disk drives
    3. Switchable composite color/80 column monitor
    4. Dot matrix printer
    5. Printer interface
    6. 128k - 256k RAM
    7. Mouse
    8. A size 1 pen plotter
    9. Plotter interface

C. High Budget System

    1. Computer
    2. One floppy disk drive
    3. One hard disk
    4. RGB color monitor
    5. Math co-processor
    6. Dot matrix printer
    7. Multi pen B, C, D size plotter
    8. Laser printer
    9. Appropriate interface
    10. Digitizer tablet
    11. 512k - 1 meg RAM

D. Accessory Options

   1. Modem
   2. Surge protectors/line filters
   3. A/B switches
   4. Printer tractor feeds
   5. Computer anti-theft security
   6. Computer furniture
   7. System clock
   8. Accelerators
   9. RAM disks
   10. Robotic arms
   11. Dust covers

APPENDIX - INDEX TO SECTIONS

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A. Periodicals

There is a multitude of periodicals which deal with virtually every facet of computers, computers in education, and Industrial Arts/Technology Education itself. What follows is a compiled list of many of these magazines. Most of the ones listed have been used as reference or resource at one time or another by the committee members. A brief categorization follows each listing. For more details on any of these periodicals, you are encouraged to seek help from your school or local public library.

Periodical	Category
1. A+	Apple & compatibles
2. American Printer	Graphics
3. Byte	Computers in general
4. CADalyst, The Journal of Auto CAD Users	CAD
5. CAD Educator Inc.	CAD
6. Design Graphics World	Design, drafting, graphics
7. Electronic Learning	Computers in Education (general)
8. Graphic Arts Monthly	Graphics
9. In Cider	Apple & compatibles
10. Industrial Education	IA/TE
11. In-Plant Reproductions	Graphics
12. Mac World	Apple MacIntosh
13. Metals Digest	Metals
14. 80 Micro	Tandy/Radio Shack

15. P.C.	IBM PC & compatibles
16. P.C. Tech	IBM PC & compatibles
17. Personal Computing	Computers in general
18. Run	Commodore
19. School Shop	IA/TE
20. T.H.E. Journal	Technology and Computers in Education (general)
21. The Technology Teacher	IA/TE

B. Software Resources

There are many sources for software and software information and advice. Software available ranges from teacher designed programs to public domain software to commercially published software. Some sources of information are listed in this section. It is suggested that, in addition, you avail yourself of information in periodicals, at trade shows and conventions, from publisher catalogs, at local computer stores, at local book stores, and at State Regional Centers such as CREC, RESCUE, Project Learn, etc.

1. *Basic Computer Programs in Science and Engineering*
   J. Gilder, Hayden Book Company

2. Connecticut Industrial Arts Association
   P. O. Box 301
   Branford, CT 06405
   (Free Public Domain Software)

3. *Computer Programs for Industrial Arts/Technology Education*
   Sarapin/Post, Goodheart-Willcox Co., Inc.

4. Connecticut Computer Society, Inc.
   180 Bloomfield Avenue
   Hartford, CT

5. *Encyclopedia of Computer Science and Engineering*
   Rhalston, Van Nostriand Reinhold Company

6. EPIE Institute
   P. O. Box 620
   Stoney Brook, N.Y. 11790
   (Educational Products Information Exchange)

7. International Council for Computers in Education (ICCE)
   Department of Computer and Information Science
   University of Oregon
   Eugene, OR 97403
   (publications on instructional use of computers)

8. International Technology Education Association (ITEA)
1914 Association Drive
Reston, VA 22091
(Public Domain Software, and other publications)

9. Journal of Courseware Review
Apple Computer
20525 Marianne Avenue
Cupertino, CA 95014
(software reviews)

10. Minnesota Education Computing Consortium (MECC)
2520 Broadway Drive
St. Paul, MN 55113
(software, site licenses)

11. National Center for Research in Vocational Education
Ohio State University
1960 Kenny Road
Columbus, OH 43210
(An Administrator's Guide to Microcomputer Resources and Microcomputers in Vocational Education)

12. Tandy/Radio Shack Education Division
400 Tandy Atrium
Fort Worth, TX 76102
(History of Technology Program)

13. The Use of Computers in Vocational Instruction (series)
American Vocational Association
2020 N. 14th Street
Arlington, VA 22201

Special Needs Information

14. Committee on Personal Computers and the Handicapped
COPH-2
2030 W. Irving Park Road
Chicago, IL 60618

15. Coordinator, Computer-Assisted Instruction
California School for the Deaf
2601 Warring Street
Berkeley, CA 94704

16. Gifted and Talented Programs
1643 LaSalle Street
Racine, WI 53404

17. Vocational Studies Center
University of Wisconsin-Madison
964 Educational Services Building
1025 W. Johnson Street
Madison, Wi 53706
(Effective Microcomputer Assisted Instruction for the Vocational Education of Special Needs Students)

C. Software Evaluation "Caveat Emptor"

Any software purchase is a significant investment. "Let the buyer beware" is by far the phrase that should be kept in mind. Good software does exist, and as the software publishers receive feedback from users the programs will get better. The overriding principle should be, wherever possible: "Try Before You Buy" to insure that the software lives up to its claim and is appropriate for the students and the task. Here are some suggestions that may be of help:

1. Request software "on approval" much as you would a textbook.
2. Many publishers will provide a "preview" or "demo" disk.
3. Dealers may provide for in-store preview sessions.
4. Ask for a list of purchasers in your area whom you might contact.

The following is a brief checklist of evaluative criteria that might be used in assessing software for purchase:

1. Good user's manual
2. Back-up disk available/copy protection
3. Site license available
4. Quantity discount available
5. Activities laid out in sequence
6. Instructions clear
7. Adaptable to other areas

8. Updates easily available
9. Menus well-designed and easily accessible
10. Menu overrides
11. User Friendly Structure
12. Built-in student evaluation
13. Help menus
14. Does the program accommodate multi-level ability students?
15. Is remediation provided when needed?
16. How does the program respond to correct and incorrect responses? i.e. on an incorrect student response does the program merely deliver the message "Sorry, wrong answer try again!" or does it guide the student through a series of well-designed hints, refreshers, etc.?

D. Glossary

A

Abort	To stop or cancel a procedure or selection in progress.
Absolute Address	The actual, physical location in storage of a piece of data that the control unit can address directly.
Access	The ability to obtain data from and/or place it into memory.
Access Time	The time it takes for information to become available once it has been called for via a control signal.
Acoustic Coupler	A device which allows a computer to talk over telephone lines. It has a cradle in which the telephone receiver fits. Electrical impulses from the computer go to the acoustic coupler which converts them into tones. These tones go out through the telephone receiver.
Active File	A file that is currently in use. In some computers which many people can use at once, if a file is active (someone is using it) no one else can use it.
Adapter	A connecting device with the plug for one kind of cable and the socket for another. It is used when the cables used to connect parts of a computer do not fit each other.
Address	An identification represented by a name, label, or number for a register or location in storage.
Algorithm	A step-by-step procedure for solving a problem.

Alphanumeric Data	Data that consists of letters of the alphabet, numerals, and other characters that can be entered through a keyboard.
Analog	The representation of a variable using physical quantities such as electrical voltage or mechanical pressure.
Analog Computer	An automatic computing device that operates in terms of continuous variations in some physical quantity, such as electrical voltage or mechanical displacement. Analog computers are primarily used to solve differential equations.
Animation	Making an inanimate object or drawing appear to move by rapidly displaying a series of pictures of it, each one in a slightly different position.
Application Software	Software that is designed to allow a computer system to perform tasks within specific disciplines such as architectural, structural, mechanical, and electronic drafting within computer aided drafting.
Architecture	The arrangement, design, and interconnection of components within the system. Also refers to the internal design of the microprocessor.
Arithmetic Component	The part of a computer system's processing unit that performs all mathematical computations.
ANSI	American National Standard Institute (Set drafting standards)
Assembler	A computer program that transforms mnemonic instructions into binary code.

Assembly Language	A low-level computer language with a set of mnemonic instructions usually having a one-to-one relationship with machine code.
Asynchronous Communication	One of the manners in which data is sent between computers. The characters are not sent at predetermined times between the two ends of the link.
ASCII	American Standard Code for Information Interchange

B

Back-up	Duplication of a program or file onto a separate storage medium so that a copy will be preserved against possible loss or damage to the original.
BASIC	Beginners' All-purpose Symbolic Instruction Code--A high-level programming language that is widely used by beginners and in simple interactive computing.
Batch Processing	The running of computer programs in groups or batches.
Baud Rate	The rate, in bits per second, that data can be transmitted over a serial transmission line (such as a telephone line).
Binary	The base-two number system that used only zeros and ones.
Bit (binary digit)	The smallest unit of digital information that can only take on values of zero or one.
Block	A generic term for any kind of grouped data (bits, bytes, words, records) handled as a single unit. It is often associated with a contiguous group of records on a disk and is accessed as a unit.

Bootstrap	A program or machine routine that is designed to bring the computer into the operating state.
Branching	A program's ability to respond to the user by adjusting both the feedback and the continuing instruction to the user's growing understanding.
Break	A interrruption of transmission.
Buffer	A temporary storage location for data. Buffers are typically used in conjunction with slow input device to better utilize computer speed.
Bug	An error in programming that causes faulty output. May also mean a hardware malfunction or design error in the computer.
Byte	A basic unit of information in a computer. Commonly consists of a sequence of eight binary bits, usually handled as a unit. One byte usually represents one character. A kbyte (kilobyte) is 1024 bytes or 1024 characters (about a half page of double spaced text).

C

CAD	Computer Aided Design/Drafting -- A system of hardware, software, and users grouped together in such a way as to perform necessary drafting and design tasks.
CAI	Computer Aided Instruction--An educational procedure supported and assisted by computers; this includes electronic tutorials and automated worksheets. Also termed Computer Assisted Instruction.

CAM	Computer Aided Manufacturing -- System using the computer and peripheral equipment to create the data base for programming the operation of manufacturing equipment such as lathes, milling machines, and drilling machines.
Card Reader	A device that can transcribe punched-hole data from paper cards into electrical impulses for input into computer memory.
Cassette Recorder	A device for storing information. Binary information is stored on a cassette tape by first converting it to audio signals and recording it on the tape. This method of storing is slower than disk.
Catalog	An ordered set of items, such as files or programs, arranged in an easy to reference structure. To index a set of items, such as a list of files.
Central Processing Unit (CPU)	Central Processing Unit controls what the computer does. It includes three main sections: arithmetic, control, and the logic elements. It performs computations and directs the functions of the computer.
Character	Single items that can be arranged in groups to stand for information. There are two forms: (1) numbers, letters, graphic symbols, etc., that can be understood by people and (2) groups of binary digits that can be understood by the computer. Character is usually represented by one byte.
Character Generator	A device used to move a CRT beam across the screen to trace the shape of an alphanumeric character.

Chip	A small, flat piece of silicon on which electronic circuits are etched. As the heart of a microcomputer, this microprocessor contains all the circuitry needed to carry out computer operations.
CIM	Computer Integrated Manufacturing
Clock	An internal device, typically a crystal oscillator, used to synchronize the timing of basic events in the computer.
CMI	Computer Managed Instruction -- The use of computer programs in the management or administration of an instructional program.
COBOL	COmmon Business Oriented Language--A high-level programming language especially useful in business applications.
Code	A sequence of program instruction to perform a specific computer task. Usually, machine code is considered to be binary.
Coding	Developing a set of computer instructions or translating "human readable" material into "computer readable" material.
Command	An instruction given to the computer through an input device or peripheral.
Compatibility	There are two types of compatibility--hardware and software. Hardware compatibility means that various components (printers, disks, keyboards, etc.) may be directly connected without intervening electronic devices and that all components use the

	same baud rate (i.e., data transmission speed), word length, and other technical aspects in order to communicate. Software compatibility refers to the ability to run programs on a variety of computers without changing the program language.
Compiler	A computer program that translates high-level program statements into machine language.
Computer	A device designed for the input, storage, manipulation, and output of symbols (digits, letters, punctuation). It can automatically follow a step-by-step set of instructions to manipulate information.
Computer Graphics	The process of delivering to the user pictorial representations of information through information processing techniques; e.g., graphs, drawings, etc.
Computer Literacy	General learning, knowledge, and fluency with computer terms and computer usage.
Computer Program	A series of instructions which the computer will follow. Each program is designed to cause the computer to perform a specific task or solve a specific problem.
Core	The main storage area in a computer. Also, in early computers, a small ferrite ring which could be magnetized to form one bit of information.
Courseware	A combination of content, instructional design, and the physical program (software) that causes a computer to complete instructions.

CP/M	Control Program/Microcomputer. A popular operating system for microcomputers. CP/M is a registered trademark of Digital Research Corporation.
CPU	Central Processing Unit--The heart of a computer system consisting of the controlling circuits, main storage, and the arithmetic-logic unit.
Crash	The condition of a system that has become unusable; the cause may be either a hardware malfunction or a software problem.
CRT	Cathode Ray Tube--A common display device resembling a television picture tube that operates using an electron beam focused on a phosphorus screen. In some cases a TV may be used for this purpose.
Cursor	A movable character or symbol, such as an arrow or rectangle, that indicates the current grid position on a screen.
Cycle Time	The amount of time associated with the most fundamental sequence of computer executions, usually measured in terms of the number of beats from an internal crystal clock. Typical cycle times are measured in terms of nanoseconds.

D

Data	The information given to or received from a computer. Data can be represented by binary digits such as alphanumeric data and other characters that appear on a keyboard.
Data Base	An organization of data files containing information or reference material on a

	particular subject or subjects. It is typically structured so that headings or keywords can be referenced easily, which allows efficient and simple access, to and retrieval of, records.
Data Processing	The input, storage, manipulation, and dissemination of information using sequences of mathematical and logical operations.
Data Set	A group of data elements that are related.
Debug	The process of finding and correcting errors in a program that might cause problems or provide inaccurate information.
Decimal	The base-ten number system.
Dedicated	Used with a single terminal by one user. Said of a microprocessor generally used for one type of work. A dedicated system stands alone.
Default Value	The value of state that a variable will assume if no preempting information is supplied.
Density	The amount of information that can be packed onto a tape or disk. Usually expressed in units of bits per inch (BPI).
Digital	The representation of information using discrete numerical values.
Digitizer	The hardware component in a computer aided drafting system that is used to convert graphic data into digital data. Either a hand held cursor or an electronic/light pen is used as an input device.

Direct Address	An address that refers to a memory location which contains the operand desired.
Direct Memory Access	The transfer of data from memory directly to peripherals.
Disk (disc)	Magnetic-coated material in a 5 1/4 inch or 8 inch record-like shape on which information and programs are stored. Information is stored randomly and can be accessed faster than on cassette type storage, sometimes called diskettes or floppy disks.
Disk Drive	A device that rotates magnetic disks and accesses its data by means of a read/write head. Disk drives are operated by disk-drive controllers and utilize the principle of random-access storage.
Display	Any visible data coming directly from a computer. Text or pictures on a monitor are examples of computer displays. The same data printed on paper would not be a display.
Documentation	The inclusion of information that supports or explains a software package. A computer program that can be documented using comment cards.
DOS	Disk Operating System--Software routines used to operate computer systems where disk storage is used.
Dot Matrix Printer	A printer that can print groups of tiny dots on a piece of paper. These dots may be arranged into the shape of alphabet letters. They also may be arranged to create a picture.

Double Density	A technique used to increase bit density on a magnetic storage medium to twice the amount of single density so that more information can be stored in the same amount of area.
Double side-Disk	A magnetic disk capable of storing information on both sides.
Down Load	To call for, and receive, a file from another computer.
Down Time	Any time a computer is turned off. Down time can be caused by a malfunction, maintenance, or modifications.
Drum Plotter	A computer output device that generates graphics on paper stretched over a cylindrical surface.
Dumb Terminal	A terminal used in most basic manner - only for simple input and output (communication) with a host computer.
Dump	The transfer of programs and data onto an auxiliary storage device or the listing of all the contents of a working storage area.

E

Editor	A system utility program that allows the user to change or correct a program with simple commands.
Eighty-column Card	A printed circuit board which can be plugged into a microcomputer so that its video display is expanded from forty columns across to eighty columns across. Better word processors use an eighty column format because a typed page usually is more than forty characters across.

Electronic Mail	Messages sent by one user and retrieved by another through an electronic service system, usually via telephone lines or radio transmission.
Electronic Spreadsheet	Software that simulates a business or scientific worksheet in which the user can indicate data relationships. When data are changed, the program has the ability to instantly recalculate any related factors and to save all the information in memory.
Electronstatic Plotter	A plotter that employs a fixed writing head with addressable electrodes. The electrodes place a charge on a coated paper that is passed through a toner.
Embedded Command	One or more characters inserted into the text that do not print but instruct either the printer or word processing program to carry out a task.
EPROM	Erasable or Electrically Programmable Read Only Memory--PROM can be erased and reprogrammed.
Erase	Remove data from memory. This can be main memory, inside the computer, or mass storage, such as on a disk or tape.
EROM	Erasable Read Only Memory--A ROM can be erased and reprogrammed.
Error	A mistake in a program or made by a user. Such a mistake prevents a computer from performing some operation.

F

Field	The most detailed unit of information storage. A file is divided into records and a record is divided into fields.

File	An organized block of information.
Firmware	Programs that are contained in a hardware device like ROM.
Fixed Point	An integer mode with no decimal point.
Flatbed Plotter	An output device used to draw a graphical image on paper, mylar, film or glass on a flat table from data previously developed on the computer systems in man readable form.
Flicker	An intermittent image caused by having more lines displayed on a CRT than can be refreshed before the phosphor fades. It is a characteristic of a CRT using only a vector generator.
Floating Point	Ability to work with a real number having decimals.
Floppy Disk Drive	A device for storing masses of information on a rotating, flexible, magnetic-coated plastic disk that is similar to a record. Information can be stored and quickly retrieved. Unlike cassette tapes the disk allows the user to go to any section of the disk without searching through immediate information.
Flow Chart	A graphical aid for understanding the logic of a program.
Format	The way information is arrange. The size of files on a disk is part of that disk's format.
FORTRAN	FORmula TRANslation--A programming language developed for use on IBM computers and often preferred by scientists and engineers.

Function Key	A control on an interactive computer system that will cause specific operation to be performed such as constructing a circle or deleting a line.

G

Gap	Empty space left between blocks of information on a disk or tape. A gap allows the computer to tell where one block of information ends and another begins.
Graphic Data	Data that is represented by lines and planes such as sketches and drawings.
Graphics	Information displayed in the form of pictures.
Graphics Tablet	A flat device which plugs into a computer for the purpose of drawing a picture or digitizing. The information will be sent to the computer and included in a program or displayed on the CRT.
Grid	A surface that is divided into squares, like graph paper. A computer display may be marked into a grid, which aides in creating graphics.

H

Handshaking	The initial exchange between two data communication systems prior to data transmission. The first unit sends a signal, then waits for an appropriate signal in response. The specific sequence in this exchange is called a protocol.
Hard Copy	Output that can be taken from the system. The most common types of hard copy are printouts, drawings, and plots. Also a small photocopy of what appears on the CRT.

Hard Disk Drive	A peripheral device for storing programs or other information on disks made of rigid aluminum, coated with a magnetic recording surface. Capable of storing large amounts of data.
Hardware	The physical components of a computer system, consisting of the central processing unit plus all of the peripherals (CRT, disk drives, plotter, printer, etc.).
Help Screen	A feature that provides advice and assistance directly on the screen.
Hexadecimal	A numbering system using the base sixteen.
High-Level Language	A language like FORTRAN or BASIC where simple statements can cause a great deal of computation.
Hybrid Computer	A computer having both digital and analog components.

I

Image	A picture created with an optical instrument, such as a television camera, a film camera, a xerox machine, an exact copy of a section of memory that has been transformed to another section of memory or to a different location in mass storage.
Impact Printer	Any printer which puts data on paper by striking an inked ribbon. Impact printers may form letters out of dots or with raised faces like typewriters.
Indirect Address	An address that refers to a memory location which contains the address of the operand desired.

Initialize a Disk	A process performed automatically by a computer. It records various signals on the disk which become markers. Afterward, the computer can find a location on the disk by counting these markers.
Input	Information going into the computer or into a peripheral device. The same data may be output from one part of the computer system and input into another part of the computer.
Integrated Circuit (IC)	A solid state device that contains many electronic circuits on one small chip.
Intelligent Terminal	A terminal with some computing and storage capabilities of its own.
Interactive System	A system that allows the user to edit or change, and to receive output almost immediately.
Interface	An electronic circuit that connects the CPU and a peripheral device (disk drive, etc.), permitting the flow of data back and forth.
Interpreter	A translation procedure that translates and immediately executes each step of the source program one step at a time.
I/O	Input-Output--Information that is input to or output from a computer.

J

Joystick	A method of manipulating a cursor on the screen or a display by tilting a lever in the desired direction of movement.

K

Keyboard	A console of keys such as those on a typewriter. The keyboard is usually attached to or a part of the CPU. The keyboard is used for input of data/information.
Keypunch	A keypunch is a typewriter-like device that punches holes in computer cards.

L

Language	A format that allows a programmer to communicate more effectively with a computer. BASIC is one of the most popular and easily used languages. A language is a defined group of representative characters or symbols, combined with specific rules necessary for their interpretation by the computer.
Laser Disk	8" or 12" hard disk containing digitally encoded information read with a laser system. The information is viewed on a television.
Laser Printer	A printer that utilizes a laser to create an electrostatic image on a drum which is then transferred to paper which then picks up the toner to form the image.
Layer	Logical two-dimensional CAD/CAM data divisions that can be viewed individually or as overlays.
Library	A collection of standard programs and subroutines made available to the user for repeated use or incorporation into other programs.

Light Pen	A digitizing device that senses the glowing phosphor on the cathode ray tube and as a result changes a function or sends a signal to the computer.
Line	This term has two meanings. One is a line drawn by a computer as part of a graphic. The other meaning is a line of text on a display or a typed page.
Line Feed	The act of advancing to the next line of text. This might be moving the cursor down one line on a monitor display or advancing the paper in a printer so that it types on the next line.
Line Number	Programs written in some programming languages are organized by lines. Each line contains one or more instructions. Each line is given a number and the computer begins executing the program with the lowest numbered line.
Listing	A display or print-out of a program.
Load	This term has two meanings. One is to transfer data from mass-storage into a computer's internal memory. The other meaning is to put a storage medium, like a disk or tape cassette, into the device which can "read" it, to a tape player.
Location	An area of computer storage which is identified by its own address.
Loop	A sequence of instructions which may be executed repetitively.

LSI	Large Scale Integration--A complex form of an integrated circuit.

M

Machine Language	A sequence of binary instruction code used directly by a machine. The code is in a form directly acceptable to a machine and requires no translation.
Magnetic Tape	A plastic tape on which data can be stored by selected magnetization of positions on the surface. The usual density of information is 800 BPI (Bits Per Inch).
Main Frame Computer	A CPU utilized with many terminals for multi-purpose use.
Main Memory	Another term for internal memory; the memory within a computer, as distinct from memory stored on tapes, disks, or other mass storage.
Main Program	A main program is a set of instructions used to begin the operation of the computer on a program and can be used to call subroutines or subprograms.
Matrix	A rectangular array of elements used for displaying digital data.
Matrix Printer	A type of printer that outputs alphanumeric data by creating characters consisting of small dots arranged in a matrix. Matrix printers can print as many as 200 characters per second.
Memory	One of the essential components of a computer's central processing unit, memory is the

	area where information and programs are actively stored and processed. Memory is comprised of both ROM and RAM.
Menu	A set of symbols on a display allowing the operator to select the next operation on an interactive system.
Microcomputer	A computer whose central processing unit is a microprocessor. Designed principally for use by a single person.
Microprocessor	An integrated circuit that executes instructions, also a central processing unit on a single chip.
Microsecond	One millionth of a second.
Minicomputer	A small computer that is generally configured for simultaneous use by a small number of people. Slightly larger and more powerful than a microcomputer.
MODEM	MOdulator-DEModulator--It is a device that permits computers to transmit information over regular telephone lines.
Monitor	A video display unit that uses a cathode ray tube (CRT) to generate characters. It looks like a normal TV set; however, the monitor has a much higher degree of resolution, which permits the clear formation of very small characters on the screen.
Mouse	Input device. It eliminates the need to use the keyboard for cursor control. By using buttons on the face of the mouse, and sliding the mouse

	across a flat surface in the direction of the desired cursor movement, the cursor can be positioned over objects on the computer screen.
Multiplexer	An interconnecting device between a central processor and two or more similar peripheral devices so they can effectively operate simultaneously on a single channel.
Multiprogramming	The simultaneous working of two or more different programs in a single computer.
Multitasking	Operating systems that allow a user to initiate concurrent tasks.
Multi-User	Used to describe operating systems that allow users to share a computer's central processing unit, storage, memory, and file resources. Each user operates a separate terminal or console.

N

Nanosecond	One-thousandth of a microsecond.
Network	A system of pathways that allow computers and peripherals to communicate with each other. A real estate office with seven PC's, for instance, might set up a local area network (LAN) to share information about current home listings.
Noise	Random interference in electronic circuits.
Numerical Control (NC)	A type of computer aided manufacturing in which electric motors receive instructions electronically from punched paper tape, or magnetic tape fed through a reader that automatically operates machine tools.

O

Off-Line	Refers to the location of data on storage devices taht are not immediately accessible to the computer. Data stored on magnetic tape, punched cards, or paper tape must be loaded into on-line storage to be available to the computer.
On-Line	Refers to the location of data on storage devices that are immediately accessible to the computer. Usually on-line data are stored on discs, in RAM, or in ROM.
Operating System	A collection of service routines that supervise the sequence in processing of programs on a computer.
Operational Software	Computer software that causes the system to perform the basic general functions such as storage, plotting, and calling from storage.
Optical ROM Disk (CD ROM)	Uses laser to read and write (once only) to a metal disk. The on bit is represented by a small bit in the disk. This is contrasted to magnetic storage media.
Optical Scanner	A device that examines or senses a multi-dimensional pattern and generates an analog or digital representation of the pattern.
Oscilloscope	An oscilloscope is a CRT device commonly used for computer fault finding and preventive maintenance.
Output	Information coming from the microcomputer to a display unit, such as a CRT or printer.

Overflow	The production of a number beyond the capacity of register.
Overlay	A technique for bringing routines into high-speed memory from peripheral storage during processing so that several routines will occupy the same memory locations at different times.

P

Paper-Tape	A method of representing information by patterns of punched holes in a length of tape, commonly used in numerical control N/C devices.
Parallel Communication	The technique of sending the bits (which make up a byte of information) through a medium simultaneously. Results in faster data transfer.
Parallel Operation	Flow of data through a computer or any part of it using two or more channels simultaneously.
Parallel Processing	The technique of utilizing multiple (micro) processors to operate multiple functions at the same time.
Parallel Storage	Storage is which each bit is some piece of information or storage area is accessed simultaneously, contrasts with serial storage when the bits are read or written one after the other.
Peripheral	A general term for devices which may be connected to a computer's central processor.
Pixel	The minimum raster display element represented as a point with a specific color or intensity level.

Plotter	A hard-copy device capable of presenting data in graphic form, such as two-dimensional curves or line drawings.
Port	A term that refers to locations where the computer can receive or send signals.
Printer	A peripheral device that accepts output data from the microcomputer and prints on paper. Printers are defined as impact or nonimpact. Impact printers strike the paper by a ribbon like that on a typewriter. Nonimpact printers from characters by electrical charges or by spraying ink.
Processor	The heart of the computer configuration holding the curcuitry for arithmetic and logical operations.
Program	The set of instructions by which a computer operates to accomplish a specific task.
PROM	Programmable Read-Only Memory--A memory device (ROM) that can be programmed after it is manufactured.
Prompt	A character or mark that appears on a CRT display indicating that the computer is waiting for the user to enter data.
Protocol	A set of rules governing communication between two systems.

Q

Queue	A waiting line for processing jobs or data.

R

RAM	Random Access Memory--The computer's general purpose memory. RAM may be written into or read from the central processing unit. RAM can be erased and re-programmed by the programmer as frequently as necessary. RAM disappears and will be lost when power to the computer is turned off.
Random Access	A memory device that may have any portion of the memory located independently of time. Access to the memory data may be in a random manner.
Raster Scan	A CRT scanning system where the beam moves horizontally across all x-values first at each y-level, moving sequentially down each y-level until the entire screen is scanned.
Reader	A general term for a hardware component that is used for interpreting the instructions set forth on punched paper tape or magnetic tape.
Real Time	Data processing with results displayed during the actual time the physical process occurs.
Record Length	The size of a data element or elements.
Refresh Display	A type of CRT display that creates an image using an electron beam. The image must be refreshed approximately 60 times per second or it will begin to flicker.
Register	Temporary working storage device for control, arithmetic operations, and logic.

Repeatability	The capability of a pen plotter in a computer aided drafting system to retrace a line or lines without altering its width.
Resolution	The amount of pixels that are assembled on a display in a defined area.
Robot	A reprogrammable, multifunctional manipulator designed to move materials, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks.
ROM	Read Only Memory--A circuit where data or instructions are programmed at the time of manufacture. ROM cannot be erased during normal operations. ROM is fixed, not volatile.
Routine	A set of machine instructions that will perform a specific job (program).
Run	Execute a program.

S

Satellite Terminal	An input/output device with a small processor that is remote from the central computer.
Scaling	Magnifying or reducing the picture of a display device.
Scrolling	Moving, with directional keys, the content of a CRT display up or down by one or more lines.
Sector	A disk is divided into tracks which are in turn divided into sectors. Tracks are concentric circles on the disk, and each

	track is divided into a number of sectors. A file may be recorded in more than one sector and on more than one track.
Seed	The term applies to a bit which is randomly planted within a randomizing function permitting the function to create a random number.
Serial	Time sequencing of two or more processes or units.
Serial Communication	The technique of sending the bits (which make up a byte of information) through a medium one bit at a time. Must be used for long distance data transfer (greater than 6 feet) and is slower than parallel communications.
Simulation	A computer program that models some real phenomena or system.
Software	Refers to programs and accompanying documentation. Software is stored on tape cassettes or disks when not being used by the computer. The computer reads the software into its memory in order to use the programs.
Source Program	Instructions written in high-level computer languages.
Speed	The rate at which a task is accomplished or the rate at which it performs.
Spooling	An interconnecting device that allows slow-speed and high-speed devices to interface.
Spreadsheet	A computer program (presented in table form) that allows the user to easily manipulate large amounts of figures and other data.

Stack Memory	A group of storage devices or elements where data is stored serially.
Step	One operation in a program or routine.
Storage	Saving of data in the memory bank of a computer system.
Storage Capacity	The quantity of bytes the storage unit can hold. Due to the large memory capacity of many microcomputers, it is usually expressed in kilobytes (i.e. "thousands" of bytes).
Subroutine	A portion of program dedicated to a specific operation.
Symbol Creation	The process wherein commonly used symbols are entered into the computer, displayed on the CRT, and then stored in memory. The symbols themselves are placed on a menu for easy reference and accessing.
Synchronous	A computer operation in which each operation follows the pulse of a master timing device.
Syntax	The sequence of commands for data input.

T

Tablet	A device which may be electronic or acoustic for digitizing data preparatory to input into the computer system.
Tape Reader	A hardware device for interpreting the instruction on punched paper tape used in a computer aided manufacturing system.
Teletype	An electric typewriter-like device that may serve as either input or output.

Terminal	A peripheral device that facilitates human communication with a computer. Usually consists of a keyboard with alphabetic and numeric characters coupled with a printing mechanism or a CRT. One enters information via the keyboard and the computer responds via the printer or CRT.
Terminal Emulator	A hardware or software provision permitting one terminal to copy the communications protocol of an other possible incompatible terminal.
Time-Sharing	Multi-user sharing of computer time simultaneously.
Track	The part of a dynamic storage device that is accessible to a reading or writing device (see "sector").
Translator	A program or routine that will convert a program in one language to equivalent statements in another language.
Turn-A-Round	Time between input of data until receipt of the output requested.
Turnkey	A computer system sold complete and ready to use for a specific application; requires no additional hardware modification or planning.

U

User	The third component in a computer system. Any person who uses a computer system to perform any type of computer task.
User Software	Special user designed software developed to meet specific on-the-job needs. The most common user software is the menu.

Utility Routine	A standard routine used to assist in the computer operation or program preparation.
User Friendly	A means of characterizing a software program according to its ease of use. Provides ample help for the operator.
User's Group	Association of people who have an interest in a particular computer. They exchange information, share programs, trade equipment, and explore new computer uses.

V

Video	Loosely, another word for television, the use of electronics to send and record pictures.
Videodisk	A thin, flat, rigid disk about the size of a 33 1/3 rpm phonograph record. Digital data is stored on a video disk in the form of tiny bits. Television pictures may be recorded digitally, as millions of ones and zeros on the disk. Most video disks are "read" by beams of laser light, and therefore, never wear out.
Vector Scan	The direct movement of the electron beam in a CRT from point to point.

W

Wire Frame	A series of thin wires or lines connected to form a three dimensional object.
Word	A sequence of bytes operated as one unit.
Word Length	Number of bits in a word, for example, a 16-bit words has two bytes.

Word Processing	Preparation of documents or printed material by use of the computer. Words may be typed, changed, stored, rearranged, filed and retrieved, formatted, edited, and printed.
Word Wrap	Keeps track of the number of characters and spaces on each line. If characters were entered beyond the right margin, words would automatically move to the next line.
Working Space	Temporary storage locations for performing current operations.
Work Station	A number of devices which when combined are used to input graphical or non-graphical data for drafting, designing or engineering. The components consist of a cursor control unit, command input devices and a video display unit.
Write	To transfer data from one storage area to another or to output.

Z

Zooming	A continuous scaling of data on a display.

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